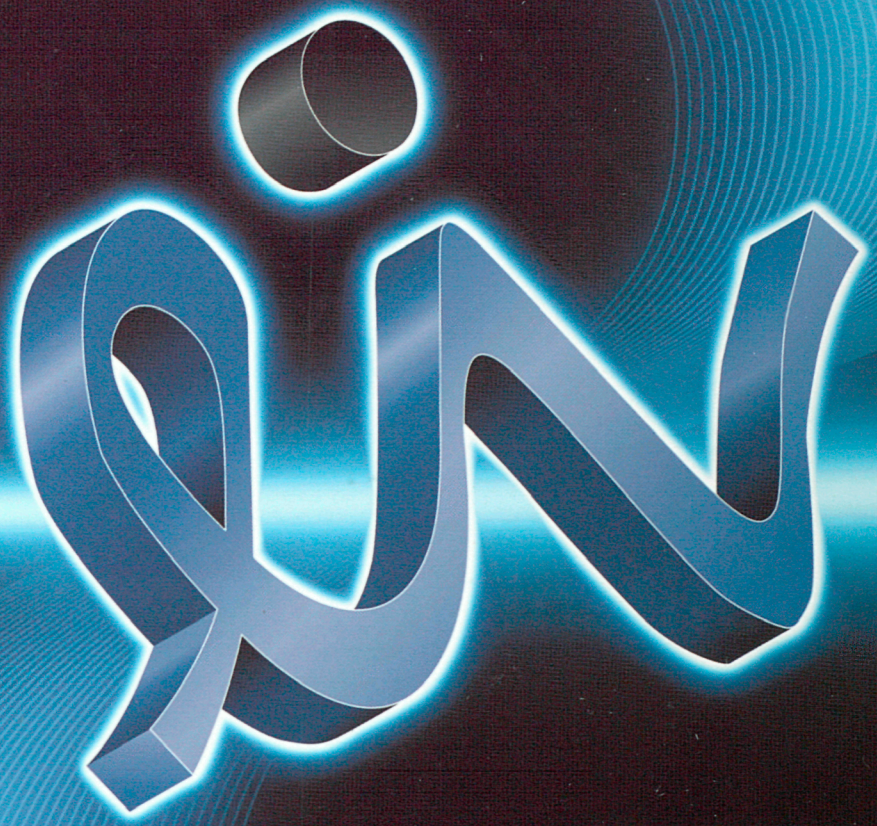

Environment Institute

Annual Report 97

JOINT
RESEARCH
CENTRE
EUROPEAN COMMISSION

Report EUR 18054 EN

European Commission

Edith Cresson

Member of the Commission responsible for research, innovation, training and youth

Directorate-General Joint Research Centre
Environment Institute

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ANNUAL REPORT 97

Environment Institute

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CONTENTS

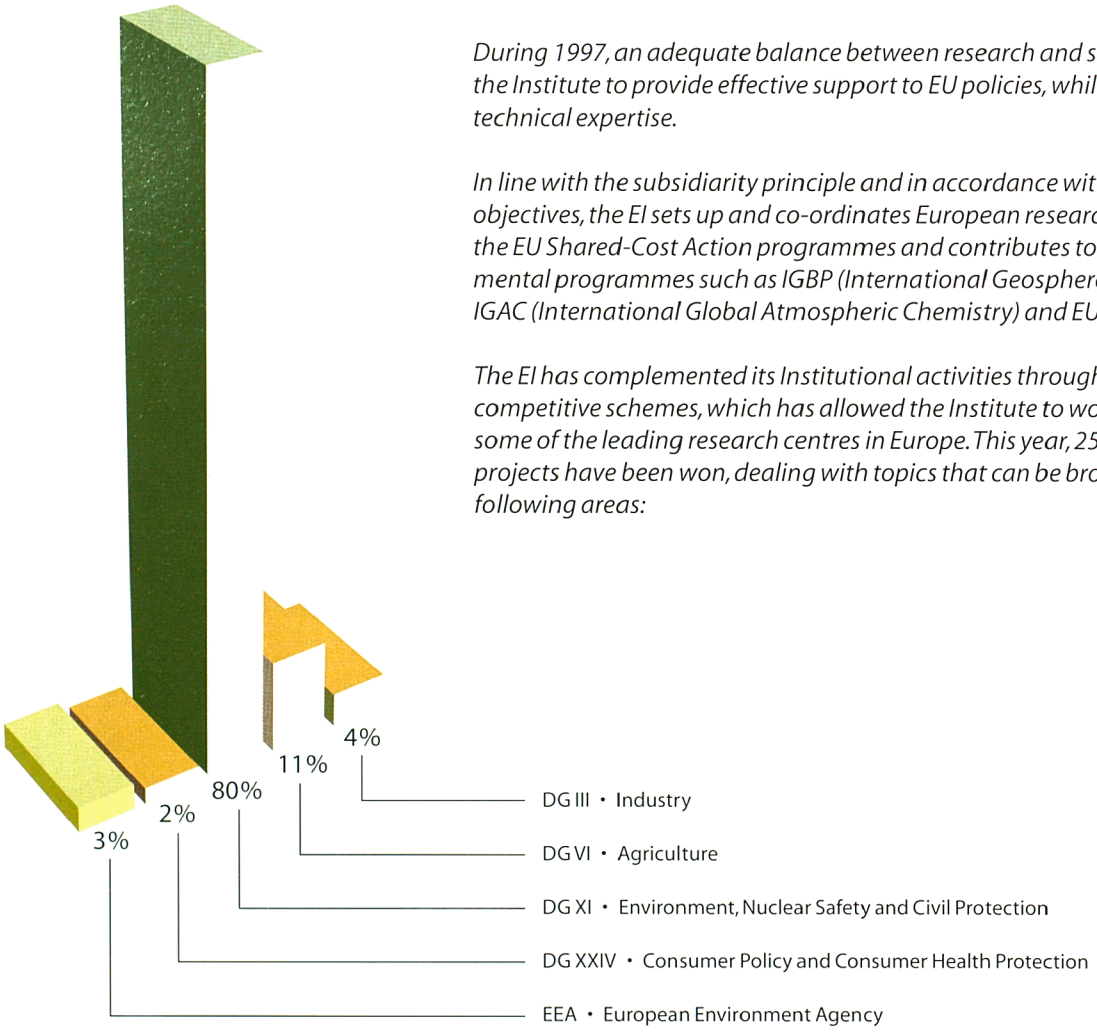
INTRODUCTION

The Environment Institute is one of the seven Institutes that constitute the Joint Research Centre of the European Commission. The Institute concentrates its efforts on protecting man and the environment, thus contributing to improving the quality of life of the European citizen.

During 1997, as its primary mission, the EI has further consolidated its role in the provision of neutral and independent scientific and technical support for the development, implementation and monitoring of the European Union Environmental Policy. This year, the resources dedicated to these support activities have represented 73% of the Institutional Budget of the EI.

The EI's main customer (80% of the support activities) is logically the European Commission Directorate-General primarily responsible for the Environment (DG XI). Furthermore, the Institute is also supporting other Directorates-General and the European Environment Agency (see figure to the left).

EI institutional customers
(1997)



The EI carries out its work by participating in some 80 international networks with more than 650 partners including universities, research organizations, national and regional official bodies and industries.

During 1997, an adequate balance between research and support activities has allowed the Institute to provide effective support to EU policies, while improving its scientific and technical expertise.

In line with the subsidiarity principle and in accordance with the EU's main research objectives, the EI sets up and co-ordinates European research projects which complement the EU Shared-Cost Action programmes and contributes to major international environmental programmes such as IGBP (International Geosphere Biosphere Programme), IGAC (International Global Atmospheric Chemistry) and EUREKA.

The EI has complemented its Institutional activities through participation in various competitive schemes, which has allowed the Institute to work in close co-operation with some of the leading research centres in Europe. This year, 25 new Shared-Cost Action projects have been won, dealing with topics that can be broadly grouped into the following areas:

- *Particles and photo-oxidants in tropospheric chemistry*
- *Climate-change effects on freshwater resources in Europe*
- *Air quality and effects of pollutants on the European population*
- *Development of analytical methods for food control*
- *Environmental risk assessment*
- *Endocrine-disrupting chemicals.*

In view of the priorities of the European Union, especially those of the 5th Framework Programme currently under preparation, and taking into consideration the recommendations of the Environment-Water Task Force, the EI will strengthen its activities in the fields of water management and quality as well as in the areas of environmental toxicology and human health and of consumer protection and food.

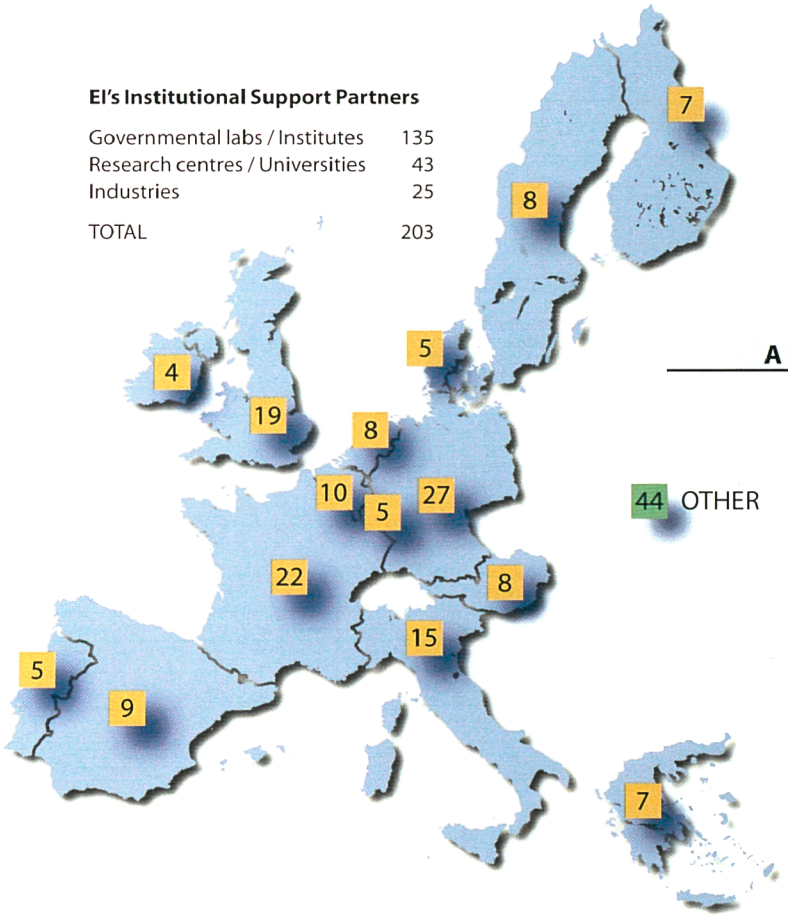
In line with the important decisions reached at Kyoto, the EU is committed to contributing to the work on various issues related to climate change. In this context, the EI will reinforce its activities on tropospheric ozone and on atmospheric aerosols which are of paramount importance in evaluating and predicting climate trends. Work on the determination of emissions will also be reinforced, particularly in the frame of the Auto-Oil Programme which will contribute to assessment of the impact of future vehicle fuels on the air quality in major European cities.

The Environment Institute is expected to further increase its institutional support to the EC Directorates-General, thus contributing to raising the quality of life and improving the quality of the environment in Europe.

J.-M. MARTIN
Environment Institute
Director

EI's Institutional Support Partners

Governmental labs / Institutes	135
Research centres / Universities	43
Industries	25
TOTAL	203



A bridge between EU policies and the European citizen

The EI networking capabilities are highly relevant to the scientific-technical support for the implementation of EU policies, facilitating dialogue between the European Commission and the key players in the Member States.

THE ENVIRONMENT INSTITUTE

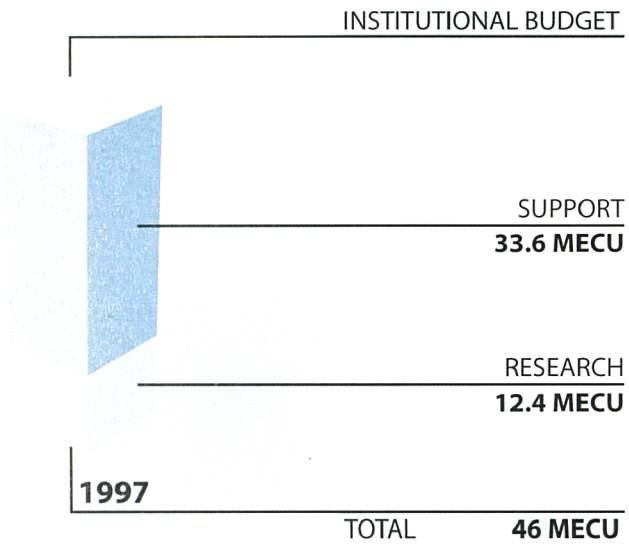
DIRECTORATE

Director: **Jean-Marie Martin**
Deputy Director: **Bruno Versino**
Adviser: **Helmut Knöppel**
Scientific Co-ordinator: **José María Jiménez**

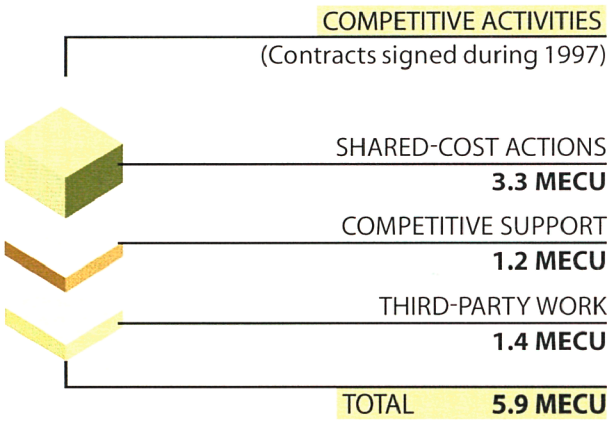
ADMINISTRATION AND TECHNICAL SERVICES

Unit Head: **Emanuela Rossi**

BUDGET

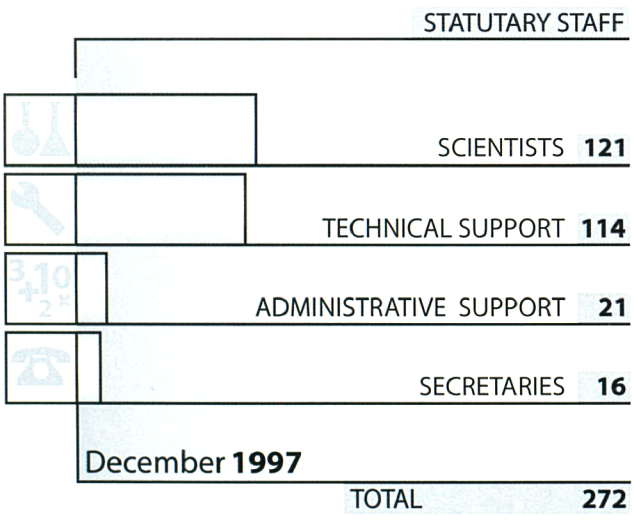


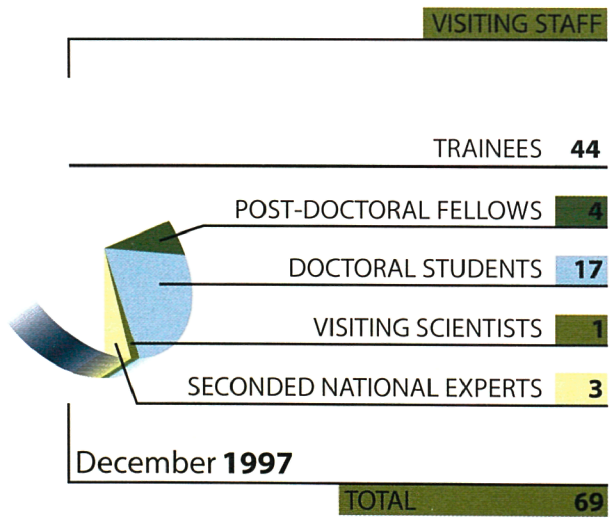
The EI activities are funded through the direct actions of the Framework Programme (Institutional Budget). During 1997 the scientific and technical activities in support of EU policies (Institutional Support) represented 73% of these resources. The remaining 27% corresponded to research activities (Institutional Research).



The EI has continued its efforts in participating in competitive schemes in fields complementary to its Institutional Activities, mainly through its participation in Shared-Cost Action projects and through services provided to the Commission (Competitive Support) and to other Third Parties (Third-Party Work).

STAFF





LEVELS & FATES OF CHEMICALS

Environmental Monitoring

Unit Head: **Giovanni Graziani (*f.f.*)** • **Dimitrios Kotzias (*from January 1998*)**

Atmospheric Processes

Unit Head: **Bruno Versino**

Soil, Water, Waste

Unit Head: **Jean-Marie Martin (*f.f.*)**

EXPOSURE TO CHEMICALS & THEIR EFFECTS

ECB: European Chemicals Bureau

Unit Head: **Gerald Vollmer**

ECVAM: European Centre for the Validation of Alternative Methods

Unit Head: **Michael Balls**

ETHH: Ecotoxicology & Human Health

Unit Head: **Peter Pärt**

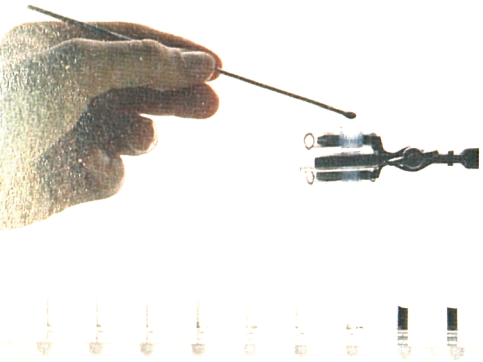
CONSUMER PROTECTION & FOOD

Food & Drug Analysis

Unit Head: **Jean-Marie Martin (*f.f.*)** • **Elke Anklam (*from February 1998*)**

CURRENT & FUTURE ACTIVITIES

LEVELS & FATES OF CHEMICALS



The Environment Institute has considerable expertise in the study of the mechanisms by which contaminants are released into the environment, their physico-chemical transformation and their impact on environment and climate.

Water research and monitoring

The research in this field has been concentrated on the following topics: water quality in coastal watersheds, water management of lakes and water re-use technology. Special emphasis has been put on the harmonization and development of analytical methods to improve the comparability of environmental data.

In the context of the Environment-Water Task Force, headed by the Institute director, intensive consultation has been carried out with all EU Member States to produce an Action Plan that will contribute to the definition of the European strategy on water quality and management under the fifth Framework Programme.

The setting-up of a European Laboratory for Water Pollution (LEPE) is underway with DG XI and other DG's, to provide the scientific and technical support needed for the preparation and implementation of the EC directives on fresh-water management and quality. The Laboratory will work in close co-operation with relevant authorities and laboratories in the Member States, to harmonize pollution control methods and to evaluate the effectiveness of water-management strategies and pollution control.

Atmospheric processes in global change

The main research activities have focused on the role of biogenic emissions in tropospheric-ozone formation, the impact of atmospheric aerosols on the radiation budget of the Earth and on the atmospheric transformation of trace constituents. The foreseen evolution of these activities will include mainly research on the relationship between photo-oxidant and aerosol formation in con-urban and sub-regional European areas and evaluation of the impact of new car fuels in urban areas.

Air quality control

ERLAP (European Reference Laboratory for Air Pollution) has continued to provide DG XI with scientific and technical support for the EC legislation on air quality, including activities in the frame of the Auto-Oil Programme, dealing with sustainable urban development. In the future, activities will continue in the fields of harmonization of monitoring methods and the development of new techniques for the measurement of priority pollutants.

Radioactivity monitoring

REM (Radioactive Environment Monitoring) has continued its support to DG XI for the implementation of community regulations on radioactivity in the environment. It is planned to make more intensive use of information technology in the near future to improve data banking and subsequent reporting, as well as to ensure radiological information exchange with the EU Member States under routine and emergency conditions.

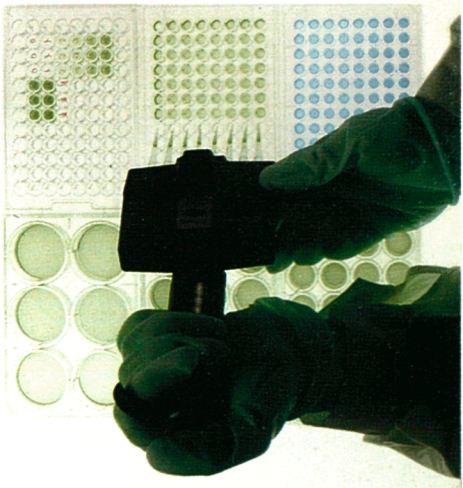
EXPOSURE TO CHEMICALS & THEIR EFFECTS

The EI has a multidisciplinary competence in the field of human and environmental exposure to chemicals and the resulting effects.

Ecotoxicology and human health

The EI work on ecotoxicology and human health is being intensified, covering toxicological studies on the environmental impact and health effects of various toxic compounds and of microbial pollution, with the aim of developing risk-assessment models and procedures. The main focus is on:

- the impact of microbial and chemical pollution of water on aquatic life and the consequent relevance to human health
- health risks of indoor air pollution, especially those related to volatile organic compounds and their control
- health effects resulting from food contamination and age-related neurodegenerative disorders.



This work is intended to provide technical and scientific support to EC legislation (DG V, DG XI) complementing the EC Shared-Cost Action research of DG XII.

Validation of alternative methods

The European Centre for the Validation of Alternative Methods (ECVAM) has continued to co-ordinate, at the EU level, in support to DG XI, the validation of alternative procedures to the *in vivo* toxicological tests currently used to assess the potential hazard to man of chemicals and various kinds of products. This work is carried to assist Commission regulatory actions on industrial chemicals, pesticides, cosmetics and other products, for the protection of consumers, of the environment, and for the benefit of European industry.

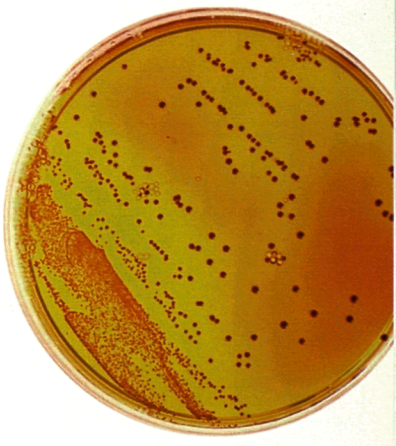
Environmental risk assessment of chemicals

The European Chemicals Bureau (ECB) has consolidated its role as the focal point for the implementation of the EC directives in the field of environmental effects of chemicals (DG XI). The work of the ECB is focused on risk assessment in relation to existing and new chemicals, in close co-operation with competent national authorities and other international bodies, such as OECD, UNEP and FAO.

CONSUMER PROTECTION & FOOD

Food quality and safety

Based on the expertise developed within the EI in the fields of analytical chemistry, nuclear magnetic resonance and microbiology, the EI has succeeded in also becoming a reference point for issues dealing with consumer protection, mainly in the fields of food, spirits, animal feeds and cosmetics.



BEVABS (Bureau Européen des Vins, Alcools et Boissons Spiritueuses) has continued to provide support to DG VI with respect to the origin and quality of European wines. During 1997, the Unit initiated validation studies in the fields of GMO (Genetically Modified Organisms) and BSE (Bovine Spongiform Encephalopathy).

The new European Laboratory for Consumer Protection, currently under discussion with DG III, DG VI, DG XXI and DG XXIV, should encompass and further develop ongoing JRC activities on food safety, origin and quality. The main objectives are to provide support to regulatory actions of the Commission and to co-ordinate scientific and monitoring work performed in the Member States, by the creation of scientific networks and encouraging harmonization of analytical methods.

LEVELS & FATES OF CHEMICALS

Environmental Monitoring

Unit Head: **Giovanni Graziani (*f.f.*)** • **Dimitrios Kotzias (*from January 1998*)**

Atmospheric Processes

Unit Head: **Bruno Versino**

Soil, Water, Waste

Unit Head: **Jean-Marie Martin (*f.f.*)**

ENVIRONMENTAL MONITORING
LEVELS & FATES OF CHEMICALS

THE UNIT'S MISSION

Environmental change is undoubtedly a major issue of present times. It falls to political and governmental bodies at all levels to translate the public concern into laws and regulations that are also consistent with other public expectations, such as social and economic development.

The Environmental Monitoring Unit is giving scientific and technical support to DG XI (Environment, Nuclear Safety and Civil Protection) in the fields of air pollution, radioactivity monitoring and observation of the Alps.

FIELDS OF ACTIVITY

The need to refer to an independent laboratory on matters related to environmental monitoring led, in 1994, to the creation of the European Reference Laboratory of Air Pollution (ERLAP) to undertake activities relevant to the implementation of Community legislation dealing with urban air quality.

Within the 4th Framework Programme for research and technology, the activity of the Environmental Monitoring Unit is mainly directed:

- to running the ERLAP laboratory;
- to supporting the Council directives on radioactive contamination of the environment, by operating a Radioactivity Environmental Monitoring programme (REM);
- to supporting and co-ordinating the activities of the Alpine Observatory.

The Environmental Monitoring Unit's main focus is to provide decision-makers with the necessary expertise and scientific means, such as:

- appropriate analytical instruments and methods in terms of precision, accuracy, rapidity of response, cost, etc.;
- data collection and information systems with sufficient temporal and spatial response to meet the legal objectives;
- modelling tools capable of giving an overall picture of environmental pollution and forecasting the effects of pollution, so as to assess the validity of pollution-control measures.

Homepage: www.ei.jrc.it/em/intro

MAJOR ACHIEVEMENTS IN 1997

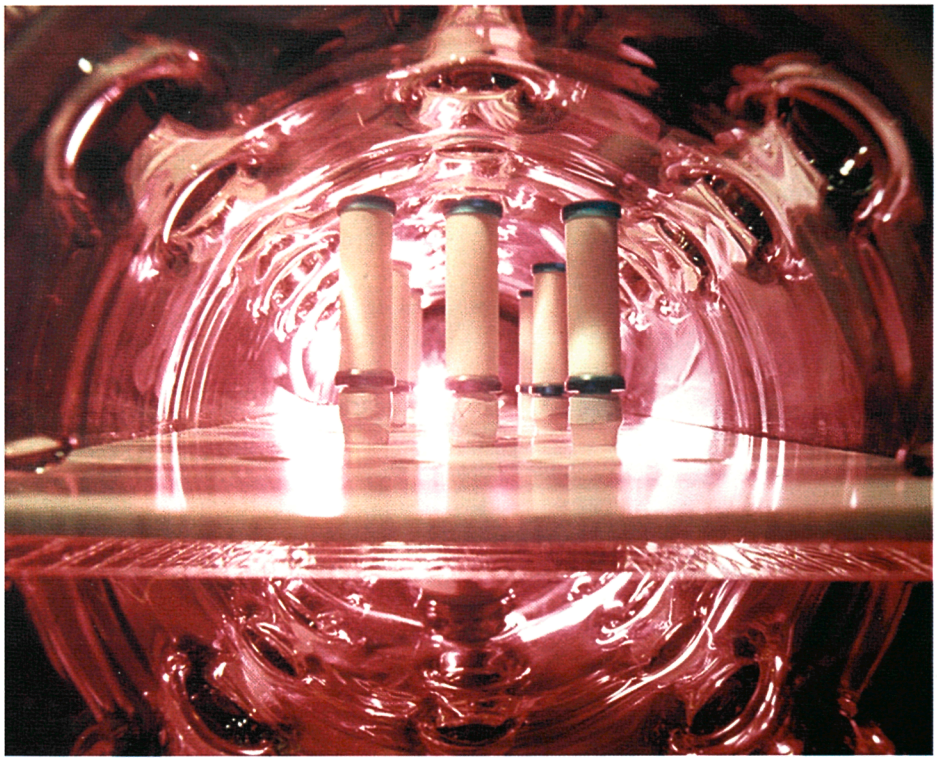
- In the context of the implementation of the newly adopted Directive on Air Quality Assessment and Management, ERLAP contributed to the revision of the SO_2, PM10, Pb and NO_2 Directives, by providing scientific and technical advice on measurement strategy to the Commission's working groups responsible for the elaboration of the directive proposals. The work in 1997 was extended to the pollutants ozone, benzene and carbon monoxide.
- Concerning the harmonization of air-quality measurements, pilot studies were carried out using the diffusive sampling technique to assess the spatial distribution of NO_2 and SO_2 and partially benzene, toluene and xylene (BTX) in Athens (GR) and Bologna (I), with a view to the design and optimization of the air-quality monitoring networks.
- The Auto-Oil studies on the impact of future vehicle fuels on urban air quality were completed for seven major European cities. ERLAP co-ordinated the modelling activities of the project.

- The performance of the European Community Urgent Radiological Information Exchange system (ECURIE), an information system for emergency response, was improved.
- Within the European Union Radiological Data Exchange Platform (EURDEP), the number of participants was increased and a data-conversion software was developed, leading currently to an exchange on a weekly basis. The data bank can be accessed via the WWW.
- The Unit successfully completed the European Tracer EXperiment (ETEX), an assessment of the capability of 28 atmospheric models to forecast the transport of a pollutant cloud in real time, and concluded it with the Vienna Symposium in May 1997.
- At the beginning of 1997, the EM Unit became the co-ordinating unit for the Alpine Observatory.
- The proceedings of the workshop Quality Assurance and Accreditation of Air Pollution Laboratories, held in October 1996, were duly prepared and distributed.

FUTURE ACTIVITIES

ERLAP will continue to provide support, during the 5th Framework Programme, for the implementation of community directives in the field of urban air pollution. In particular, in the fields of harmonization of monitoring methods and the development of new techniques for the measurement of priority pollutants. Auto-Oil will be part of ongoing activities in support of Commission services, to tackle questions of sustainable urban development. Moreover, the Unit's future activities will also be directed towards the evaluation of the emission of hazardous compounds by waste incineration.

REM will continue its support for the implementation of community regulations on radioactivity in the environment: in particular, more intensive use will be made of information technology to improve data banking and subsequent reporting, as well as to ensure radiological information exchange with the EU Member States under routine and emergency conditions.



The ERLAP exposure chamber for the testing of diffusive samplers

European Reference Laboratory for Air Pollution (ERLAP)

Monitoring of Air Pollution, Quality Control and Support to Policy Makers of DG XI

On behalf of Directorate-General XI, Unit D3 (Air quality, urban environment, noise, transport, energy) and in support of environmental legislation dealing with air pollution, the European Reference Laboratory for Air Pollution (ERLAP) contributes to the harmonization of air-pollution measurements in the European air-quality monitoring networks by a number of actions. www.ei.jrc.it/em/projects/ERLAP

In view of the preparation by the Commission of new air-quality regulations, ERLAP assesses the performances of the measurement techniques available in the EU Member States for establishing reference methods for sampling, analysis and calibration of priority air-pollutant measurements. Additionally, new measurement techniques are developed and validated with respect to sampling, calibration and monitoring including particulates.

To ensure the quality and the comparability of air-pollution measurements in the European air-quality monitoring networks, Quality Assurance/Quality Control programmes are carried out in collaboration with the Member States through the organization of round-robin tests, inter-laboratory exercises and spot checks in the monitoring stations.

In 1997, ERLAP participated in the EU *Life* project MACBETH (Monitoring of Atmospheric Concentration of Benzene in European Towns and Homes). The aim of this project is to expand the level of knowledge on environmental pollution in the European Union Member States, with special emphasis on benzene, so as to provide the Council with experimental data from environmental concentrations and personal exposure levels. Partners from six European countries are involved in this project. The sampling is carried out by means of diffusive sampling. ERLAP's responsibility is the quality assurance and harmonization of the measurement methodology. The project will provide an overview of the ambient benzene concentrations across Europe and the corresponding exposure levels of the population; it will be completed in 1999. www.ei.jrc.it/em/projects/em/MACBETH

Benzene distribution in the city of Padova

Pilot studies are co-ordinated and performed in response to particular problems in the monitoring of air quality. Particular attention was given to: design and optimization of monitoring networks, assessment of air-pollutant levels in urban areas and areas at risk, and validation and demonstration of new air monitoring techniques. With a new method for simultaneous diffusive sampling of sulphur dioxide and nitrogen dioxide in ambient air, a survey campaign in Athens was carried out: 166 sampling sites in urban areas and 16 at hot-spot sites were selected in the greater Athens area for the survey.

A field VOC intercomparison exercise in London was organized. The performance of a variety of continuous and discontinuous VOC monitoring techniques was compared during a two-month field intercomparison at an urban background location in Eltham, London. The exercise involved the use of a continuous cycling gas chromatograph (CCGC), continuous BTX analysers (FID and PID), a continuous methane/non-methane hydrocarbon (NMHC) analyser, pumped tube samplers, canister samplers and diffusive samplers. The analysis and interpretation of the results revealed the importance of the traceability of the calibration standard and the procedure and methodology of sampling calibration and analysis. Furthermore, it offered an overview of the performance of current VOC measurement techniques.

In the framework of the UN Economic Commission for Europe (UN-ECE), the Unit has been operating the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) station since 1985, providing information on the deposition and concentration of air pollutants and on the long-range transport of pollutants across national boundaries.

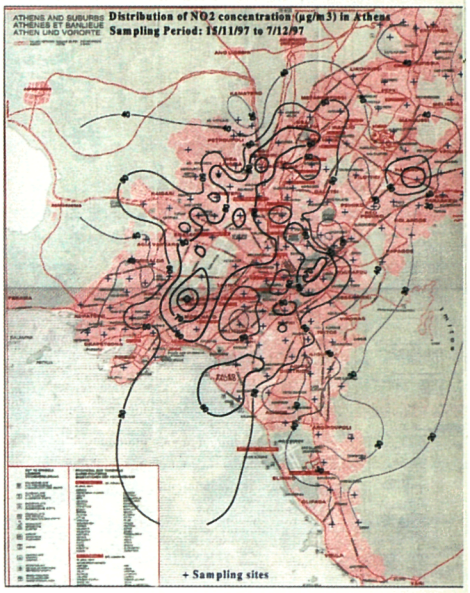
HAMAQ (Harmonization of Air Quality Measurements in Europe) is a joint project of various European laboratories for the intercomparison of primary calibration techniques, looking at the components sulphur dioxide, nitrogen dioxide, nitrogen monoxide, carbon monoxide and benzene. It is a three-year project, started in 1997, and the results will provide information on the equivalence of available 'primary' standards, their method of use, stability of the gas cylinders and know-how.
www.ei.jrc.it/em/projects/HAMAQ

The European Auto-Oil studies aim at the definition of reduction of man-made emissions to achieve the future air-quality objectives. The Unit is co-ordinating the modelling part of the Auto-Oil studies. www.ei.jrc.it/em/projects/AUTO-OIL

A first European Auto-Oil study was designed to identify the best measures, which could be introduced from the year 2000. It was an unprecedented co-operative project between the European Commission, the European automobile and oil industries and the Environment Institute. The aim was to determine the most cost-effective means of reaching air-quality objectives by the year 2010.

While Auto-Oil I was designed to identify the best measures, which could be introduced from the year 2000, the objectives of the second Auto-Oil are enhanced to extend the range of pollutants and to decide upon air-quality targets and emission-reduction targets over a wider time horizon. Various predictive models will be used to estimate emission reductions for urban pollutants. These are based on existing air-quality objectives and new World Health Organization (WHO) air-quality guidelines for Europe. Eleven representative cities of different characteristics have been selected: Athens, Berlin, Dublin, Helsinki, Cologne, London, Lyons, Madrid, Milan, Reggio Emilia and Utrecht. The modelling work which started in 1997 includes among others:

- analysis of air quality in these domains to identify the simulation periods
- linking urban to regional air-quality analysis
- calculation of predicted air quality with respect to the urban ozone, CO, benzene, NO_2 and PM10 for the base year (1995)
- validation of the modelling results



Map of nitrogen dioxide concentrations in Athens

Selected Publications

- Skouloudis, A.N. (1997). The European Auto-Oil Programme: Scientific Considerations. *Issues in Environmental Science and Technology*, **8**:67-93. Royal Society of Chemistry.
- Kassomenos, P., Flocas, H.A., Skouloudis, A.N., Lykoudis, S., Asimakopoulos, V., Petrakis, M. (1998). Relationship of Air Quality Indicators and Synoptic Scale Circulation at 850 hPa Over Athens during 1983-1995. *Environmental Technology*, **19**:13-24.
- Skouloudis, A.N., Bianconi, R., Bellasio R. (1988). Air-Quality Prognosis for the Implementation of Abatement Strategies over Large Urban Areas. *Environmental Monitoring & Assessment*. Kluwer Academic Publishers.

- assessment of micro-scale (street canyon/street) level concentrations
- grouping and validation of emission-reduction scenarios (post-optimization analysis)
- description of city representativeness over all European Member States.

DG XI asked for scientific support in the preparation of a proposal for a directive on the emission and deposition of heavy metals and dioxins by cement production plants using waste as a secondary fuel. In this context, ERLAP organized a workshop on co-incineration. The aim of the workshop was to collect information on the practice of using waste fuel in cement production. It was held in Belgirate (I) on 9-10 October 1997 with 66 participants, including staff from the Commission, national experts and representatives of the waste and the cement-production industry. Later on an in-depth study of the fate and problems of mercury in waste incineration was carried out. The report will be published in 1998.

ERLAP contributes to the international collection of data on the total ozone column, co-ordinated by the World Meteorological Organization (WMO), by operating a Brewer spectrometer to determine the total ozone column. Measurements of the total ozone column at Ispra were pursued to contribute to the 1996-1997 and the incoming 1997-1998 northern-hemisphere ozone-mapping campaigns in the framework of the *Global Ozone Observing System*. The measurements of solar UV were continued; the main effort in 1997 was on improving the accuracy of the data that are sent to the data-base centre of the SUVDAMA (Scientific UV Data Management), a shared-cost action. The overall goal of this project is to provide a scientific interpretation of the ground-based spectral UV measurements on the basis of an improved understanding of the radiative transfer processes. In August 1997, a sunphotometer was brought into operation for the determination of the atmospheric aerosol content. The instrument was included in the NASA-AERONET world network and the data measured were transmitted by satellite to NASA's Goddard Centre, to facilitate retrieval of aerosol optical depth.

Selected Publications

- De Saeger, E., Gerboles, M., Rau, H., Payrissat, M. (1997). European Comparison of nitrogen dioxide calibration methods quality assurance programme No 1, QAP/1 of the Euro-pean directive for nitrogen dioxide. EUR Report 17661 EN.
- De Saeger, E., Noriega Guerra, A., Pérez Ballesta, P., Gerboles, M., Rau, H., Amantini, L., Payrissat, M. (1997). Harmonization of Directive 92/72 on Air Pollution by Ozone. Inter-comparison of Calibration Procedures for Ozone Measurements. EUR Report 17662 EN.
- Payrissat, M., Gerboles, M., Sieja, B., De Saeger, E. (1997). Quality Assessment of Ambient NO, NO_2 and SO_2 Measurements in European Monitoring Networks. EUR Report 17671 EN.

Radioactivity Environmental Monitoring (REM)

The Radioactive Environmental Monitoring group of the Unit provides software programmes and data banks for information and data exchange under routine and emergency situations. www.ei.jrc.it/em/projects/REM

Data banking and reporting

The Radioactivity Environmental Monitoring (REM) data bank contains more than 1,000,000 measurements on radioactivity levels in the environment from 1984 onwards in almost all European countries. It is freely accessible via the Internet.

Information was provided by the EU Member States in the framework of the Euratom Treaty, with a view to preparing EU environmental monitoring reports. For this purpose, special-data input software (Easy-Proteo) and conversion processors were developed and are being used by the majority of the EU Member States, thus ensuring data checking and a standardized data exchange format, thereby accelerating reporting.

REM also contains a large data set related to the Chernobyl accident; the data are intended for use in further scientific studies. As part of the European Commission-Confederation of Independent States (EC/CIS) Collaborative Programme on the Consequences of the Chernobyl Accident (DG XII, Unit F6: Radiation protection) an Atlas on caesium deposition in Europe was prepared (using a geographic information system and advanced spatial interpolation techniques) and will be published in April 1998.

Automatic gamma dose-rate monitoring stations participating in EURDEP (situation in December 1997)

International nuclear-emergency data-exchange systems

In case of a nuclear emergency with transboundary effects, it is vital that relevant information be quickly and accurately exchanged at an international level.

Through the European Community Urgent Radiological Information Exchange (ECURIE) system, coded messages can be exchanged between national contact points in the EU Member States and the Commission (DG XI, Unit C1: Radiation protection). Currently, the REM group focuses its support on:

- the further development and maintenance of a PC encoding-decoding software CoDecS, including modules for automatic transfer of messages
- the further development of the on-line ECURIE data bank (restricted access) and relevant WWW interface to query the information. java.ei.jrc.it/ecurie/ecurie.html

With the European Union Radiological Data Exchange Platform (EURDEP), automatic monitoring data are currently exchanged on a weekly basis with 17 countries. Major achievements in 1997 were:

- the establishment and implementation of the on-line EURDEP database and related query interface. This data bank can be accessed (restricted) via the WWW java.ei.jrc.it/eurdep/eurdep.html
- an increase in the number of participants, and the development of data format conversion software
- an increase in the number of users.

Selected Publications

■ De Cort, M., Seynaeve, R., Vadé, S. (1997). Environmental Radioactivity in the European Community 1992. EUR Report 17265 EN.

The European Tracer Experiment (ETEX)

The ETEX project progresses towards its conclusion

The European Tracer EXperiment (ETEX), an ambitious project to test, in real time, atmospheric models used for long-range pollutant dispersion and consequent assessment to respond rapidly to a major nuclear accident was successfully concluded with the Vienna Symposium (May 1997). www.ei.jrc.it/em/projects/ETEX

In autumn 1994, two separate releases of tracer chemicals (perfluoro-methyl-cyclo-hexane in the first and perfluoro-methyl-cyclo-pentane in the second) over Brittany, France, were tracked across northern Europe using an extensive network of 168 ground stations, taking almost 7,000 samples, and supported by samples taken by three low-flying aircraft. Simulating a nuclear emergency response, modellers from 20 countries from western and eastern Europe, North America, Israel and Japan, reported their long-range dispersion predictions out to 60 hours in the future. The modellers were required to provide their predictions initially within a few hours of the release, and then to update their results over the following days as meteorological forecasts were replaced by observations.

Measured ground concentration contours 60 hours after the release of the tracer gas

Most of the models tested predicted plume movement satisfactorily during the first 36 hours after the first release. However, even in these ideal conditions, most model performances significantly declined for prediction over more than 36 hours even using meteorological observations. In less ideal, but by no means complex, weather conditions as in the second release, the inability of models to predict the tracer cloud movement or surface concentrations was a surprising, but major, result of ETEX.

Since nuclear accidents do not only occur during simple weather conditions, more research and development is required to improve model performance under more general meteorological conditions. For a wider range of meteorological conditions, a comprehensive benchtop model inter-comparison (RTMOD) is being planned as an initial follow-on to ETEX, to test how the different models handle transport and dispersion, whether their solutions converge and to seek the reason for their behaviour.

Selected Publications

■ Nodop, K. (ed.). (1997). Proceedings of ETEX Symposium on Long-Range Atmospheric Transport Model Verification and Emergency Response, Vienna, 13-16 May 1997. EUR Report 17346 EN.

System for the Observation of and Information of the Alps (SOIA)

Institutional support to policies of DG XI

The creation of the *System for the Observation of and Information of the Alps* (SOIA or *Alpine Observatory*) was decided in December 1994 and confirmed in February 1996 by the Alpine Conference of the Ministers of the Environment. The Co-ordination Unit of the SOIA was set up within the Environmental Monitoring Unit at the beginning of 1997, following the former support provided before the operational start of the SOIA, to lead and co-ordinate actions on the implementation of the SOIA programme. www.ei.jrc.it/em/SOIA

The general organizational structure of the SOIA is based on a network of 8 national Communication Centres and the Co-ordination Unit (acting as Communication Centre of the European Community and the secretariat of the Working Group "Alpine Observatory"). The Standing Committee of the Alpine Conference has confirmed the rules of procedure proposed in April 1997 by the Working Group "Alpine Observatory" until the end of 1999. The first rules on the dissemination of the information of the Alpine Observatory were also agreed.

The implementation plan for the six activities of the SOIA programme 1997-1998 was approved in June, leading to the following actions:

- The specifications of the *environmental indicators* – nature, forests and water – were proposed and approved; the indicators for water were defined during a workshop; preparatory work on the elaboration of indicators for air has been carried out in parallel.
- The specifications of the *socio-economic indicators* (demography, economy and employment, agriculture, tourism, transport and energy) were proposed and agreed by the end of 1997. A draft on the demographic indicators obtained during the pilot phase has been produced and will be published for the Alpine Conference in 1998.
- Within *SIRA* (*System of Information on Research regarding the Alps*) the design of the documentation of the research results was established, while the activity on the module "organizations" was carried on.
- The work on the implementation of the *Alpine Catalogue of Data Sources* according to EEA rules, which are not applied in all countries, is on-going.
- Regarding *cartography*, specifications based on the evaluation of questionnaires on the required data (topography, hydrology, infrastructure and urban areas) were proposed in co-operation with the Space Applications Institute.
- A *Communication System* situated on the WWW was tested internally, while the architecture of the public Web site to be opened on the occasion of the next Alpine Conference was elaborated.

KNOW-HOW, INSTRUMENTS & LABORATORIES

How can pollutants moving in the air from one country to another be tracked?

Tracers such as perfluorocarbon substances (PFC) can be released into the atmosphere and the air movement can be studied by taking samples at various distances from the release, using:

- mobile laboratories
- programmable sequential samplers
- PFC analysers able to detect PFCs in the femtolitre range.

This equipment and the experts needed to enable the Unit's Tracers Group to pursue tracer experiments on a meso- to long-range scale. The data bases can be used to validate atmoshperic long-range-transport model-validation campaigns, such as the European Tracer Experiment (ETEX).

Air Quality in Towns and Countryside

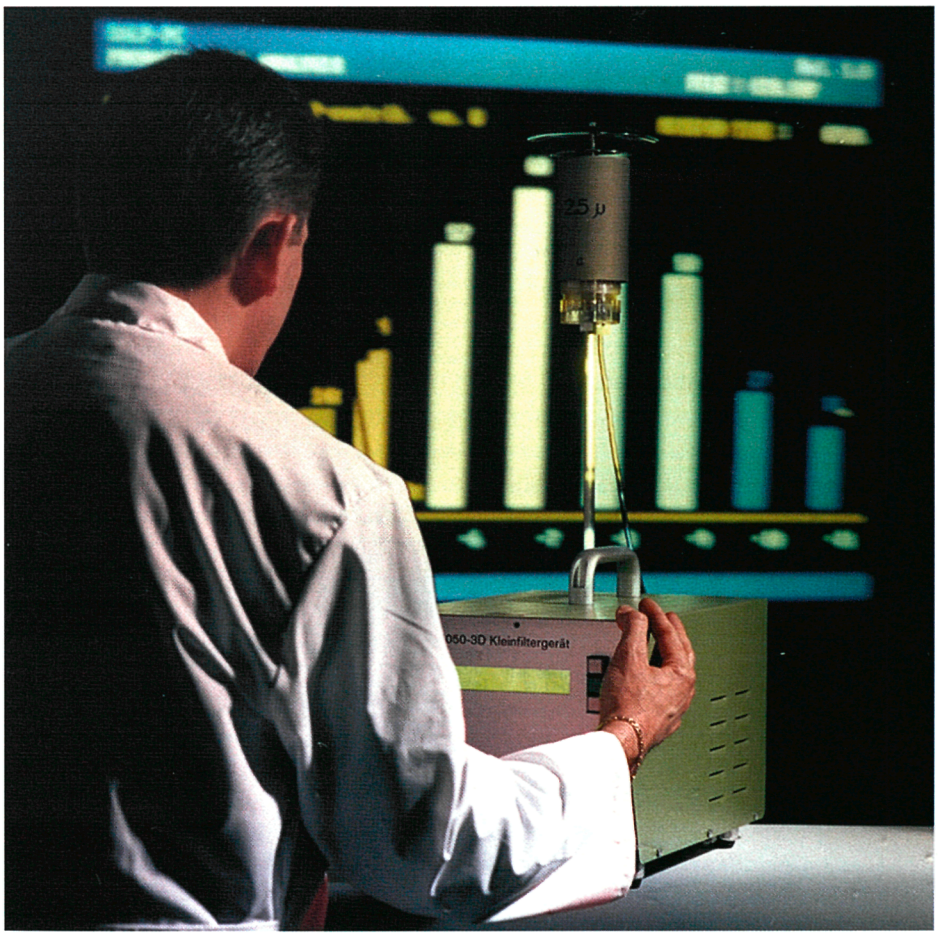
The European Reference Laboratory for Air Pollution (ERLAP) answers questions on air quality by using technology and expertise at its disposal to:

- organize and carry out air-monitoring campaigns
- develop and validate new measurement techniques for air samples
- organize pilot studies of air-quality monitoring
- model pollution to assess urban air quality
- contribute to international air-quality monitoring programmes
- carry out groundwork for air-quality regulations
- harmonize current directives

Mobile laboratories equipped with hi-tech facilities such as remote sensors for tracking pollutant emissions from tall stacks, differential optical absorption spectrometers, and instruments to calibrate monitoring stations in the field, enable ERLAP to measure air quality and map pollutant concentrations at ground level. The laboratories are also equipped to measure ozone, nitrogen oxides, sulphur dioxide, ammonia, formaldehyde and aromatic hydrocarbons.

The ERLAP laboratory prepares and certifies gas calibration standards and multi-pollutant gas mixtures for intercalibrations and intercomparisons. It also has the facilities and expertise to apply a range of chemical and physical analytical techniques, from wet chemistry to non-destructive spectrometry. ERLAP also works within the Evaluation Monitoring European Pollution (EMEP) network, to inform governments of the deposition and accumulation of air pollutants, the extent of air-borne pollutants and their movements across national boundaries.

www.ei.jrc.it/em/facilities



Sampling instrument for fine particles (PM 2.5)

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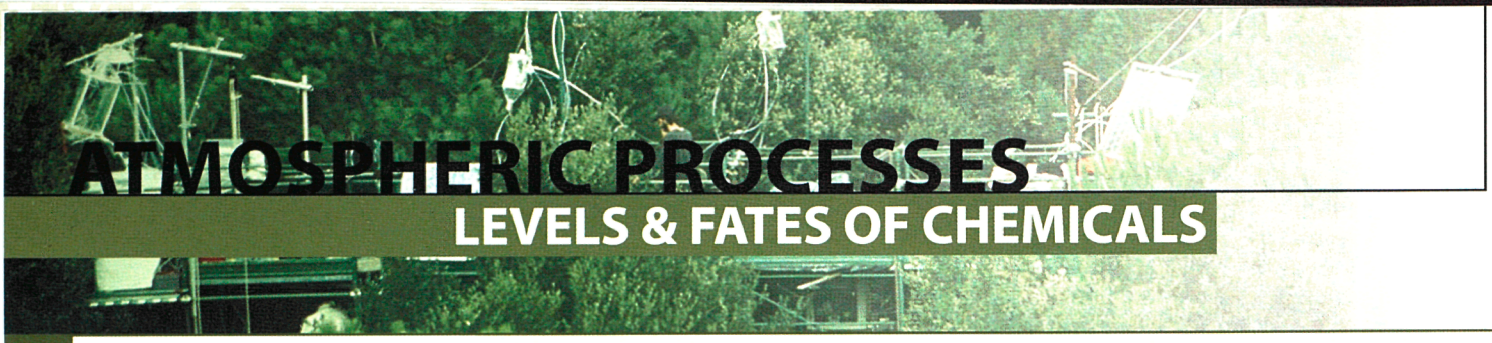


ATMOSPHERIC PROCESSES
LEVELS & FATES OF CHEMICALS

THE UNIT'S MISSION

Changes in atmospheric composition pose one of the largest threats to the stability of the environment, with small changes in the release of some gases potentially having unexpectedly large and lasting global effects.

The Atmospheric Processes Unit studies complex physico-chemical atmospheric processes and contributes to the European assessment of global change and of the relevance of tropospheric ozone to Europe. An understanding of these is now a key element in the development of environmental policies.

The Unit has a dual role: it carries out research and co-ordinates European projects.

FIELDS OF ACTIVITY

The activities focus on issues relevant to Europe:

- Biogenic Emissions in the Mediterranean Area (BEMA): their role in tropospheric ozone formation.
- Aerosols and climate: the impact of atmospheric aerosols on the radiation budget of the Earth.
- Photochemistry and chemical kinetics: atmospheric transformation of trace constituents.

Most of the Unit's activities are part of EC shared-cost action (SCA) Environment and Climate Programme 1994-1998 of DG XII (Science, Research and Development). They contribute to: the International Geosphere-Biosphere Programme (IGBP)'s International Global Atmospheric Chemistry Project (IGAC) for which the Unit runs the European IGAC Project Office (EIPO); the Global Atmosphere Watch (GAW) of the World Meteorological Organization and EUROTRAC-2 (a EUREKA environmental project). The Unit's activities are also relevant to the regulatory work of DG XI (Environment, Nuclear Safety and Civil Protection); for example, with respect to the EC directives on ozone and aerosol particles.

Homepage: www.ei.jrc.it/ap/intro

MAJOR ACHIEVEMENTS IN 1997

- The Unit continued to be successful in competitive research actions. It won 9 out of 26 of the Shared-Cost Action proposals presented; such a high percentage (35%) testifies to the high competence and scientific reputation of the Unit.
- In the Aerosol and Climate Project, the Unit successfully co-ordinated and gave a scientific contribution to IGAC's second international Aerosol Characterization Experiment (ACE-2) which involved 50 laboratories and 250 scientists from Europe and the USA. ACE-2 investigated the effect of pollution aerosols from Europe and of dust aerosols from North Africa on the radiation balance over the NE Atlantic Ocean. In this experiment (June-July 1997), six ground stations, 6 aircraft and one ship were deployed in the area between Portugal and Tenerife.
- In the BEMA project, a model-driven Lagrangian experiment was performed in May/June in Valencia's "citrus belt" (E), under the co-ordination of the AP. It included simultaneous measurements, at five ground stations, of emission rates, canopy fluxes and meteorological/air-chemical parameters. In addition, measurements based on aircraft and tethered balloons were made to characterize transport and chemistry in the boundary layer of the model domain, involving 17 laboratories.
- A Special Issue of the international journal *Atmospheric Environment* (Vol. 31, No S1,

pages 1-256, December 1997; Guest Editor: G. Seufert) was published. This Special Issue is totally devoted to the results of the BEMA project first phase and, in particular, to the results of the 1993 and 1994 measurement campaigns at the test site in the Castelporziano (Rome, I) nature preserve.

- New information on the role of terpene oxidation products in the formation of atmospheric aerosols and photo-oxidants was obtained, through laboratory studies in Ispra and through participation in two international experimental campaigns carried out at the two large (~200 m^3) outdoor chambers of the European Photoreactor (EUPHORE) in Valencia (E). This work was done within the framework of an EU project on the role of biogenic emissions of volatile organic compounds (BIOVOC) in atmospheric chemistry.
- The Unit developed a three-dimensional, dynamic photochemical model, coupling the chemical box model's regional atmospheric chemistry model (RACM) and Lurman, Carter and Coyner (1987) (LCC) with the thermal vorticity model (TVM) code for meteorology to simulate the impact of biogenic emissions on air chemistry and ozone formation in the BEMA test area in Castellón (E).
- The off-line transport model TM2 (developed at the Max-Planck Institute in Hamburg, D) was used as the basis for the determination of the global sulphur cycle, the sulphate aerosol model M3, and the global black-carbon cycle. This modelling now provides a more realistic description of aerosols in global models, in particular the mixing of sulphate and black carbon and this will eventually allow physically consistent estimates of the radiative forcing by aerosols.
- The fast photochemistry leading to the generation of ozone in the atmosphere was studied by field measurements of peroxy-radicals and other relevant parameters, in Ispra and in a field campaign in Norway in collaboration with the Norwegian Institute for Air Research.

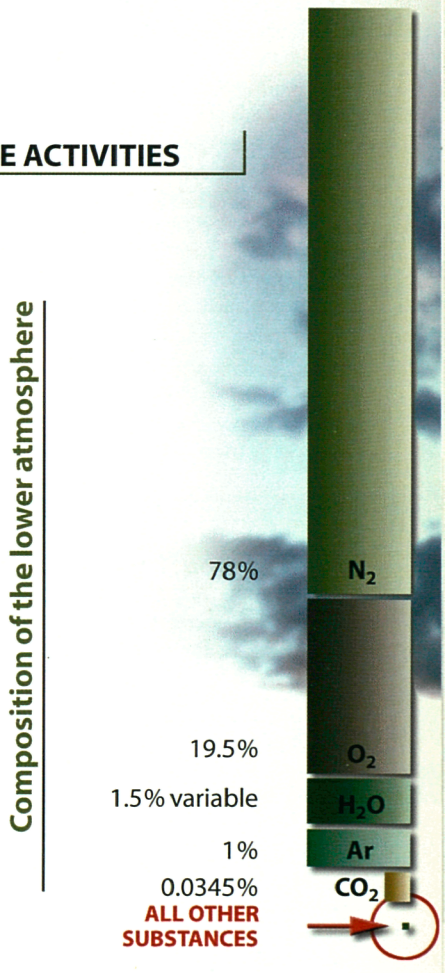
FUTURE ACTIVITIES

1998 will be devoted to data treatment and to finalizing the results obtained during the BEMA, ACE-2 and EUPHORE campaigns. In addition, several of our shared-cost action projects will end in 1998 and the final results and final reports will be published. The set-up of a unique instrument, based on laser sizing and ionization of single aerosol particles followed by the characterization of their chemical composition by time-of-flight mass spectrometry, will also be accomplished during 1998.

Activities beyond 1998, under the 5th Framework Programme (1999-2003), will include:

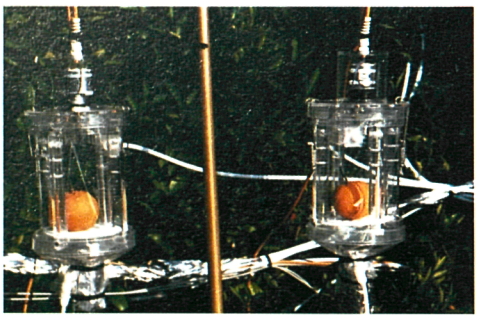
- Investigation of the relationship between photo-oxidant and aerosol formation in con-urban and sub-regional European areas, particularly in the Mediterranean basin. Photo-oxidants represent one of the most important environmental problems, owing to their effect on crops and vegetation; the negative radiative forcing of aerosols is one of the unknown parameters in assessing the balance of the radiative forcing of the troposphere in the context of global warming. In addition, photo-oxidants and particles are known for their negative effect on human health.
- Evaluation, in urban areas, of the impact of new car fuels containing alcohol/ether mixtures, which are likely to increase the concentration of aldehydes in air and play a key role as precursors of atmospheric oxidants and in particle emissions from new diesel engines, which are the source of important negative health effects.

The activities will contribute to the EC shared-cost action programmes and major international projects such as the IGBP/IGAC project and will support the implementation of air quality directives of DG XI.



Representation of the well known composition of the lower atmosphere. Practically all the complex physico-chemical processes affecting the troposphere are governed by a very minor fraction of its components, represented by the tiny dot at the bottom of the picture

The French experimental aircraft ARAT was instrumented to characterize physical and chemical properties of the boundary layer in the 100 km corridor of the model domain. In the foreground of the figure, some details of the flux measuring tower with trap-enrichment eddy correlation for measuring fluxes of volatile organic compounds



Detail of an enclosure system to analyse simultaneously biogenic emissions from most relevant individual sources; i.e., fruits and flowers of orange and mandarin. One flower emits amounts of terpenoids similar to 1 m^2 leaf surface; with more than 100,000 flowers per tree, this is by far the dominant emission source during the 1-3 month flowering period. The compounds emitted from all different sources of Citrus species are highly reactive terpenoids, most of them disappear rapidly within the canopy

Biogenic Emissions in the Mediterranean Area (BEMA)

The BEMA project, Biogenic Emissions in the Mediterranean Area, aims at comparing the contribution of such emissions, as well as man-made emissions, to atmospheric chemistry and ozone formation in the Mediterranean area.
www.ei.jrc.it/ap/projects/BEMA and www.gsf.de/BEMA/bemahome.htm

The BEMA project was divided into two phases. During phase I, 1993-1995, several field campaigns were carried out in representative Mediterranean ecosystems of Italy, France and Spain to evaluate emission fluxes under different physiological, meteorological and soil conditions in different seasons. The campaigns were complemented by laboratory studies on the emissions from individual plants and on the photochemistry of the emitted compounds. The campaigns were joined by European laboratories covering all disciplines needed to improve our understanding of the complex interactions between emissions, transport, concentrations and air chemical transformations. The goal of phase II, 1996-97, was to scale biogenic emissions up to regional levels and to evaluate their ozone-forming potential.

Being the last year of BEMA phase II, 1997 was focused on modelling/upscaling. A larger scale experiment was performed in May/June 1997 in the Castellón area (E) by all 17 laboratories involved in BEMA, to test the multidimensional meteorological/chemical model developed so far. The experiment included simultaneous measurements of emission rates, canopy fluxes, and meteorological/air-chemical parameters at five ground stations in an 80-km corridor in a land-sea breeze direction. In addition, measurements based on aircraft and tethered balloons were performed to characterize transport and chemistry in the boundary layer of the model domain. This test area appeared to be well suited for model validation, owing to the very regular land-sea breeze system and to the homogenous, large scale emission source.

The numerical modelling of dynamic photochemical coupling included the following steps:

- Application of chemical box-models to BEMA findings, to improve understanding of the various chemical pathways. In collaboration with the Fraunhofer Institute, Garmisch (D), and the Ecole Polytechnique Fédérale de Lausanne (CH), the chemical models RACM and LCC were intercompared for various emission scenarios and showed a significant impact of biogenic emissions on ozone formation.
- Simulation of the impact of emissions on air chemistry and ozone formation in the BEMA test area in Castellón (E), through the use of a three-dimensional, dynamic photochemical model, by coupling the chemical box models just referred to with the TVM code for meteorology. Test runs with the data of previous BEMA campaigns in this area were performed to evaluate the model and to understand better the particular meteorological and air chemical processes in the test area. Preliminary results of these runs showed a relatively low impact of biogenic compounds on ozone formation compared to man-made compounds. The more complete study of the 1997 campaign is currently being carried out.

As a follow-up to BEMA in 1998/99, several SCA projects were initiated by the Unit and were approved for funding by the EC Environment and Climate programme of DG XII:

- ECOVOC, on parametrization of environmental and physiological controls of VOC emissions from European forests. www.ei.jrc.it/ap/projects/ECOVOC
- Volatile organic canopy modelling (VOCAMOD), on biogenic-emission modelling for European forest canopies. A BEMA complementary project, to run in 1998-99, is MEDEFLU, which is part of a European network and a contribution to the IGBP-Biospheric Aspect of the Hydrological Cycle (BAHC) global flux network initiative FLUXNET. The Atmospheric Processes Unit contributes a test site in Liguria to the study of fluxes of carbon, water and biogenic volatile organic compounds (BVOC)

in Mediterranean forests, and to understand better the impacts of land-use/land-cover changes. www.iata.fi.cnr.it/medeflu/minute.htm

During the second year (1997) of the EU 14C-VOC project (natural and human contributions to ambient volatile organic compounds), a method developed at JRC (Ispra) for the sampling and clean-up of atmospheric carbonyl compounds for radiocarbon (carbon-14) measurements was applied in three European field campaigns: Castelporziano near Rome (I), Aveiro (P) and Jülich (D). The radiocarbon data, obtained from accelerator-mass spectrometry measurements of the isolated carbonyl compounds performed by the University of Utrecht, showed that ambient air over semi-rural to semi-urban areas in Europe contains three major carbonyls (formaldehyde, acetone and acetaldehyde) of a higher biotic (60-90%) than human (10-40%) origin. The results will be compared with radiocarbon data on other volatile organic compounds under investigation by the partners of the 14C-VOC project and a final report will be published in 1998. www.ei.jrc.it/ap/projects/14CVOC

The MEDFLUX project (quantification of pollutant dry-deposition on Mediterranean ecosystems) is focused on the measurement of chemical deposition fluxes in southern Europe. An intercomparison campaign was conducted in May 1997 near Madrid as a quality-assurance experiment for the validation of surface-flux measurement methods. Long-term measurements were carried out at the Ispra site with a similar goal. Algorithms were developed to detect phenomena that can lead to artefacts impairing the data. These algorithms are based on the analysis of the fine structure of the fluctuations that generate the fluxes; they led to the detection of non-stationary situations where the hypotheses on which the measurement method is based are not fulfilled. www.ei.jrc.it/ap/projects/MEDFLUX

Aerosols and climate project

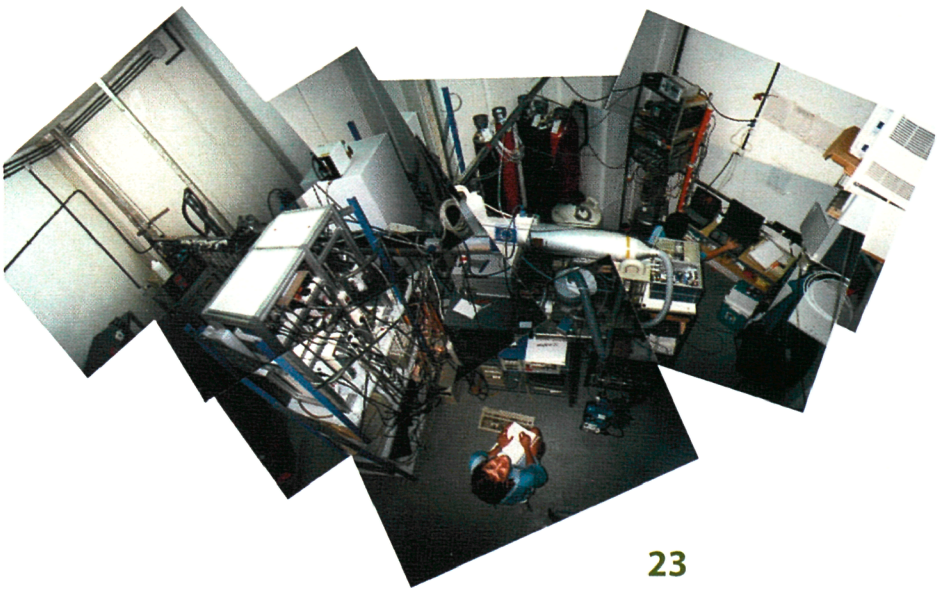
The objective of this project is to contribute to the assessment of the impact of atmospheric aerosols on the radiation budget of the Earth, and to determine the extent to which this impact varies as a result of human activities and natural phenomena.

The project encompasses field observations and management of a world data base of such observations on behalf of WMO, together with modelling and laboratory studies.

The project included two SCAs: FREETROPE (free tropospheric aerosols and their mixing with the marine boundary layer) and SINDICATE-II (study of the indirect and direct climatic influences of atmospheric trace gas emissions). www.ei.jrc.it/ap/projects/SINDICATE

Selected Publications

- Seufert, G., Bartzis, J.G., Bomboi, T., Ciccioli, P., Cieslik, S., Dlugi, R., Foster, P., Hewitt, C.N., Kesselmeier, J., Kotzias, D., Manes, F., Pérez-Pastor, R., Steinbrecher, R., Torres, L., Valentini, R., Versino, B. (1997). An overview of the Castelporziano experiments. In: (G. Seufert, ed.) BEMA–A European Commission Project on Biogenic Emissions in the Mediterranean Area. *Atmospheric Environment*, **31-S1**:5-18.
- Moncrieff, J., Valentini, R., Greco, S., Seufert, G., Ciccioli, P. (1997). Trace gas exchange over terrestrial ecosystems: methods and perspectives in micrometeorology. *J. Experimental Botany*, **48**:1133-1142.
- Cieslik, S., Labatut, A. (1997). Ozone and heat fluxes over a Mediterranean pseudosteppe. *Atmospheric Environment*, **31-S1**:177-184.
- Bertin, N., Staudt, M., Hansen, U., Seufert, G., Ciccioli, P., Foster, P., Fugit, J.-L., Torres, L. (1997). Diurnal and seasonal course of monoterpene emissions by *Quercus ilex* L. under natural conditions – Application of light and temperature algorithms. *Atmospheric Environment*, **31-S1**:135-144.
- Staudt, M., Bertin, N., Hansen, U., Seufert, G., Ciccioli, P., Foster, P., Frenzel, B., Fugit, J.-L., Torres, L. (1997). Seasonal and diurnal patterns of monoterpene emissions from *Pinus pinea* L. under field conditions. *Atmospheric Environment*, **31-S1**:145-156.
- Hansen, U., van Eijk, J., Bertin, N., Staudt, M., Kotzias, D., Seufert, G., Fugit, J.-L., Torres, L., Cecinato, A., Brancaleoni, E., Ciccioli, P., Bomboi, T. (1997). Biogenic emissions and CO_2 gas exchange investigated on four Mediterranean shrubs. *Atmospheric Environment*, **31-S1**:157-166.
- Thunis, P., Cuvelier, C. (1997). Report on the preliminary BEMA model simulations using data from Castelorziano (near rome, Italy) and Burriana (near Valencia, Spain). EUR Report 17291 EN.



Monica Mangoni (I) surrounded by gas and aerosol instrumentation during the ACE-2 campaign. The air was sampled through a 50 m-high tube which was installed in a lighthouse and entered the instrumentation room in the upper left corner of the picture. All instruments were connected to this central manifold

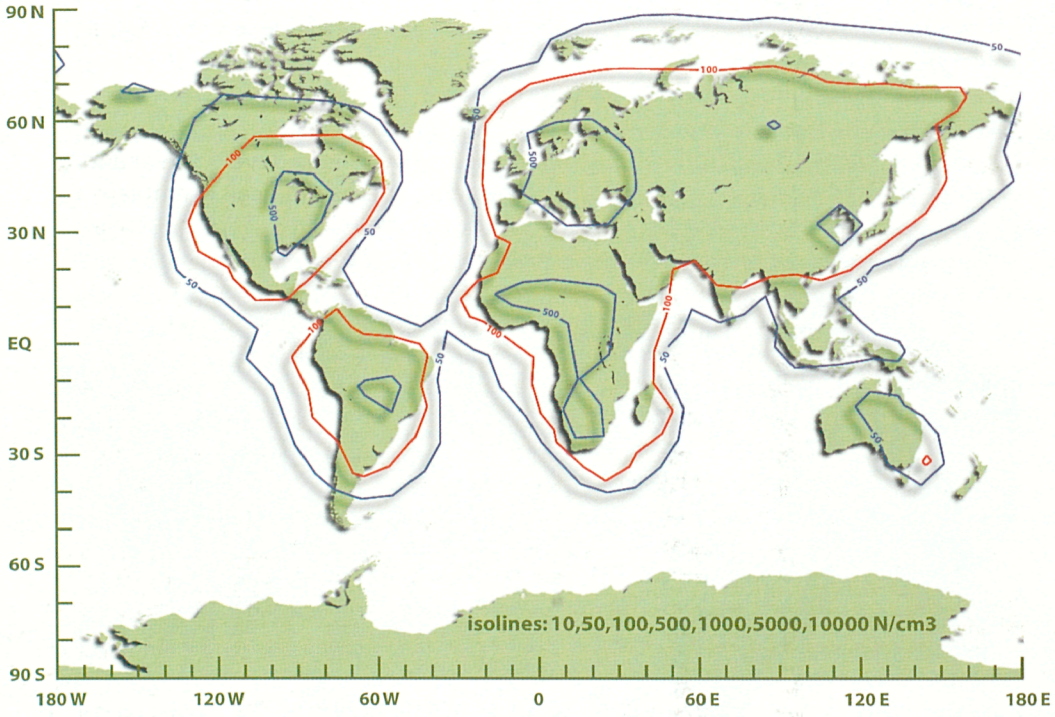
Selected Publications

- Raes, F., Van Dingenen, R., Cuevas, E., Van Velthoven, P.F.J., Prospero, J. M. (1997). Observations of aerosols in the free troposphere and marine boundary layer of the subtropical Northeast Atlantic: Discussion of processses determining their size distribution. *J. Geophysical Research*, **102**:21315-21328.
- Schult, I., Feichter, J., Cooke, W.F. (1997). Effect of black carbon and sulfate aerosols on the global radiation budget. *J. Geophysical Research*, **102**:30107-30117.
- Larsen, L.A., Roth, B., Van Dingenen, R., Raes, F. (1997). Photolytic aerosol formation in SO_2-HNO_2-H_2O-air mixtures, with and without NH_3, *J. Aerosol Sci.*, **28**(Suppl.1):S719-S720.
- Cuvelier, C., Wilson, J. (1997). Modelling the ageing and removal of black carbon aerosol. *6th Int. Conf. on Carbonaceous Particles in the Atnosphere*, Vienna, Austria, 1997.
- Vignati , E., Raes, F., Berkowicz, R. (1997). On the internal and external mixing of aerosols in the H_2SO_4-H_2O and soot system. *Northern Symposium on Aerosols*, Goteborg, Sweden, 1997.

In 1997, the major activity within the project was the scientific and technical co-ordination of IGBP/IGAC's second Aerosol Characterization Experiment (ACE-2), which investigated the effect of pollution aerosols from Europe and of dust aerosols from North Africa on the radiation balance over the NE Atlantic Ocean. ACE-2 involved 250 researchers from 50 laboratories in Europe and the USA. Six ground stations, 6 aircraft and one ship were deployed in the area between Portugal and Tenerife. Our team also participated with state-of-the-art aerosol and gas characterization at sea level and at 2300 m altitude, to document, among other things, the various air masses that were arriving in the ACE-2 area. Data from all participating labs are presently in the ACE-2 data archive at the JRC. One major result of ACE-2 was the detection of the hypothesized "indirect aerosol effect", by which pollution aerosols alter the reflective properties of clouds and hence the atmospheric radiation balance.
www.ei.jrc.it/ap/projects/ACE-2

The Aerosol and Climate project continued its studies to represent aerosols in global circulation models (GCMs) realistically. An aerosol module describing sulphate and black-carbon aerosol size distributions was developed and thoroughly tested in the off-line global model TM2. Initial steps were taken to implement the GCM ECHAM-4 of the Max Planck Institute for Meteorology in Hamburg.

During the SINDICATE-II Meeting at Ispra, Prof. Paul Crutzen, Nobel Prize for Chemistry 1996, addressed the gathered JRC atmospheric scientists and stressed the importance of aerosol particles in atmospheric chemistry on global and local (e.g. urban) scales. He particularly pointed out the coupling between photo-oxidants and aerosol particles and the need for high-quality measurements.



Annual mean surface-level concentrations of accumulation-mode sulphate and mixed sulphate/black-carbon aerosols predicted by the aerosol chemical tracer transport model TM2-M3. Accumulation-mode aerosols are of interest in climate studies because they have both a direct radiative effect and an indirect effect on cloud optical properties via their role as potential cloud condensation nuclei. Such global aerosol-number fields permit improved assessments of these radiative effects, which to date have been based on emprical functions of the total aerosol mass

Photochemistry and chemical kinetics

The objective of this activity is to contribute to the understanding of the chemical processes involved in photo-oxidant production and aerosol formation from the oxidation of natural and man-made volatile organic compounds.

Particular emphasis was placed on the understanding of the role of emissions of reactive biogenic compounds with respect to photo-oxidant and aerosol formation in a polluted and in a non-polluted atmosphere. The research on photochemistry and chemical kinetics included participation in several collaborative (SCA) EU projects, as well as third-party work.

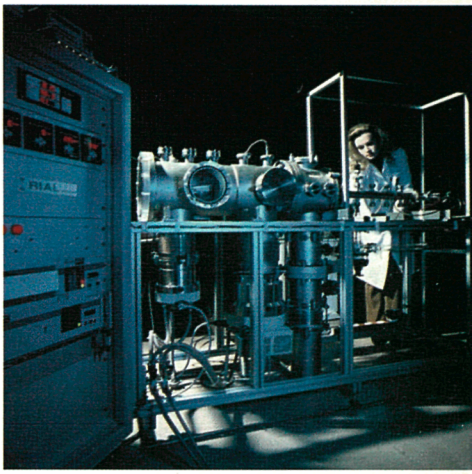
The laboratory investigations of the atmospheric oxidation of 2-methyl-3-buten-2-ol (an important biogenerated organic compound) were finalized. It was concluded that all of the relevant atmospheric chemical degradation pathways produced significant yields of acetone. Acetone, which is one of the most abundant oxygenated compounds in the remote atmosphere, is believed to play an important role in atmospheric chemistry, because of its ability to photolyse and thereby produce highly reactive free radicals.

The atmospheric chemistry of terpenes (organic compounds emitted into the atmosphere in large quantities from vegetation) was studied using the 480-litre reaction chamber in Ispra, as well as in the two large (~200 m^3) EUPHORE reaction chambers in Valencia (E). The generation of semi-volatile products and aerosols was particularly addressed. This work was carried out within the EU BIOVOC project which is co-ordinated by the JRC. www.ei.jrc.it/ap/projects/BIOVOC

Also, in the context of the shared-cost action projects NUCVOC (nucleation processes of biogenic volatile organic compounds – www.ei.jrc.it/ap/projects/NUCVOC) and PARFIN (characterization of engine exhaust particulate and the contribution to air quality – www.ei.jrc.it/ap/projects/PARFIN), laboratory studies were started on photochemical and heterogeneous processes leading to the formation and modification of organic aerosols in the troposphere. Dedicated procedures for the analysis of polar and non-volatile (condensable) reaction products were developed based on large-volume-injection gas-chromatography mass spectrometry of derivatized aerosol samples and on atmospheric pressure ionization mass spectrometry (API-MS-MS). The BIOVOC and the first NUCVOC experiments lead to the identification of novel carboxylic and dicarboxylic acids in secondary organic aerosols which may play an important role in tropospheric aerosol formation.

Tropospheric peroxy-radicals play a key role in the processes leading to the formation of ozone in the troposphere. The JRC is involved in the development and application of a new technique for the measurement of peroxy-radicals in ambient air, the so-called 'chemical amplifier' technique. An instrument based on this principle, built at the University of Bremen (D), was tested in the laboratory and applied in field measurements in Ispra and in a field campaign at Kjeller (Norway), carried out in collaboration with the Norwegian Institute for Air Research. These measurements were combined with other chemical and physical (e.g. UV radiation) measurements to provide data for testing our understanding of the mechanisms leading to the formation of ozone and other photo-oxidants in the troposphere. The research on peroxy-radical measurement is part of ongoing EU collaborative projects: the Peroxy-Radical Intercomparison Exercise and the Peroxy Radical Initiative for Measurements in the Environment (PRICE 2 and PRIME). www.ei.jrc.it/ap/projects/PRICE2 and www.ei.jrc.it/ap/projects/PRIME

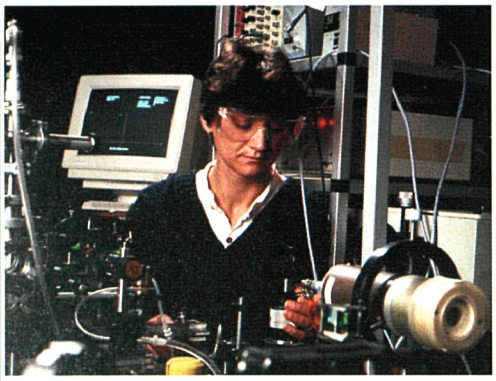
Aromatic hydrocarbons, mainly emitted from human sources, may form noxious nitro-derivatives by chemical reactions taking place in the troposphere. Such reactions have been studied by the JRC in collaboration with the University of Milan and are now being addressed in an EU project involving more partners, on Uptake



A chemical-ionization mass-spectrometry flow system being tested in the laboratory for photochemistry and chemical kinetics of the AP Unit (G. Fantechi (I), with the system)

Selected Publications

- Glasius, M., Calogirou, A., Jensen, N. R., Hjorth, J., Nielsen, C. J. (1997). Kinetic study of gas-phase reactions of pinonaldehyde and structurally related compounds. *Int. J. Chem. Kinet.*, **29**:528-533.
- Bolzacchini, E., Hjorth, J., Meinardi, S., Orlandi, M., Restelli, G., Rindone, B. (1997). Nighttime Tropospheric Chemistry: the reactivity of alkyl- and alkoxytoluenes with NO_3 in gas phase. In: Minisci, F. *Free Radicals in Biology and Environment*, Kluwer Academic Publishers, Amsterdam, 409-422.
- Saastad, O., Hjorth, J. (1997). Measurements of sensitivity for different peroxy radicals of the "Chemical Amplifier" technique. Proceedings of the conference *Air Pollution 97*, Sept. 16- 18, 1997, Bologna (I), 847-852.
- Hjorth, J., Fantechi, G., Jensen, N. R., Kotzias, D. (1997). Atmospheric degradation mechanisms and ozone forming potentials for biogenic VOC. Proceedings of the conference *EUROTRAC-2 subproject CMD*, Zurich (CH), Sept. 25-26, 1997, 112-114.
- Calogirou, A., Larsen, Bo R., Lahaniati, M., Duane, M., Kotzias, D. (1997). Oxidant scavenging by noxon for the analysis of oxygenated terpenoids in air. *Atmos. Environ.*, **31**: 2741-2751.
- Larsen, Bo R., Bomboi-Mingarro, T., Brancaleoni, E., Calogirou, A., Cecinato, A., Coeur, C., Chatzianestis, I., Duane, M., Frattoni, M., Fugit, J.-L., Hansen, U., Jacob, V., Mimikos, N., Hoffmann, T., Owen, S., Pérez-Pastor, R., Reichmann, A., Seufert, G., Staudt, M., Tranos, S. (1997). Sampling and analysis of Terpenes in Air: An Interlaboratory Comparison. *Atmos. Environ.*, **31-SI**:35-49.
- Larsen, Bo R., Versino, B., Angeletti, G. (ed.). (1997). The Oxidizing Capacity of the Troposphere. Proceedings of the *Seventh European Symposium on Physico-Chemical Behaviour of Atmospheric Pollutants*. EUR Report 17482 EN.



Laser photofragmentation-fluorescence set-up for the characterization of atmospheric aerosols. Montserrat Hidalgo (E) is adjusting the alignment of two laser beams in the gas/aerosol cell shown on the left of the picture

Selected Publications

- Neuhauser, R., Panne, U., Niessner, R., Petrucci, G.A., Cavalli, P., Omenetto, N. (1997). On-line and *in-situ* detection of lead aerosols in atmospheric by PS-LIF. *Analyt. Chim. Acta*, **346**:37-48.
- Beissler, H., Bachmann, K., Raes, F., Petrucci, G.A., Omenetto, N. (1997). Applicability of gold as an atmospheric aerosol tracer. *Atmos. Environ.*, **31**:2329-2336.
- Petrucci, G.A., Cavalli, P., Omenetto, N. (1997). Rapid, size-segregated elemental analysis of lead and gold in ultrafine (0.2-0.4 m) particles by ESP-GF-LIF. *Spectrochim. Acta*, Part B, **52**:1597-1615.

and Nitration of AROmatics in the tropospheric aqueous phase (UNARO). www.ei.jrc.it/ap/projects/UNARO

Dimethyl sulphide (DMS), emitted in megaton quantities from sea water, where it is produced by algae, is believed to make an important contribution to the formation of particulate matter in the marine troposphere, but to quantify and fully understand this contribution, more knowledge is needed about the chemical degradation mechanisms of DMS. This issue was addressed in a modelling study, showing the potential importance of heterogeneous processes for the fate of DMS in the atmosphere. A collaborative EU project on laboratory studies of DMS chemistry (Dimethyl sulphide: Oxidation Mechanism in relation to Aerosols and Climate – DOMAC) was initiated. www.ei.jrc.it/ap/projects/DMS

Laser spectroscopic studies

The understanding of the origin and nature of atmospheric aerosols and their role in the physics and chemistry of the atmosphere is a major concern of the Unit.

The Laser Laboratory for Atmospheric Studies (LLAS) is involved directly in the physico-chemical characterization of atmospheric aerosols.

The research is concentrated in the following topic and development:

- The formation of sulphuric acid aerosols as a result of the complex mechanism of DMS oxidation, investigated on-line using several laser-based techniques, such as photofragmentation, plasma emission and fluorescence, in the framework of the collaborative European Project DOMAC. www.ei.jrc.it/ap/projects/DOMAC
- The assembly of a unique instrument, based on laser sizing and ionization of single aerosol particles followed by the characterization of their chemical composition by time of flight mass spectrometry. The goal to be reached with this instrument is its operation in the field and on-line (so as to avoid any sampling artefacts), and the development of a capability to assess variations in the composition of single particles. The instrument will allow the analysis of aerosol particles whose size can vary from a few tens of nanometres to several micrometres. The major applications foreseen are the speciation of sulphur compounds (DMS, H_2SO_4), the characterization of automobile exhaust emissions and the study of gas-to-particle conversion.

KNOW-HOW, INSTRUMENTS & LABORATORIES

The Atmospheric Processes Unit can organize and conduct atmospheric field studies on the transformation of organic compounds in air (natural and human emissions), as well as on the formation and characterization of atmospheric aerosols.

Tree exposure chambers and cuvettes are used to measure the emissions of natural substances and gas exchange by individual branches and plants. On the plant-canopy scale, emission fluxes are measured by combining observations and micrometeorological parameters with emissions, using eddy accumulation and correlation techniques. Methods are available for sampling and clean-up of carbonyls suitable for radiocarbon (carbon-14) determination of the biogenic contribution of these compounds in air.

Automatic aerosol observation stations have been constructed and are run by the Unit. These take samples and measure aerosol number and concentration, aerosol size distribution, light absorption and scattering, as well as standard meteorological parameters. The stations can operate on-line, sending data back to a control centre.

The direct analysis of polar and non-volatile organic compounds in aqueous matrices such as aerosols is also available.

The Unit has high-tech instrumentation for analysing atmospheric field samples, including:

- capillary-column gas chromatography/mass spectrometry systems for volatile organic compounds (VOC) analysis and liquid chromatography MS-MS for polar organic compounds
- a gas-chromatographic system, with a gold-wire trap, for the measurement of dimethylsulphide (DMS)
- an ion chromatograph for the analysis of the water-soluble fraction of aerosols
- a home-made field instrument for measurement of sulphur dioxide (Saltzman method, high-performance liquid chromatography, with fluorescence detection)
- a home-made field instrument for measurement of peroxy-radicals ('chemical amplifier'), developed in collaboration with the University of Bremen (D).

The Unit has advanced facilities for laboratory studies of rates and products of gas-phase chemical reactions relevant to atmospheric chemistry. The instrumentation for these studies includes:

- a photochemical reaction chamber which is evacuable and equipped with on-line long-path IR and UV/Visible spectrometers
- Teflon bags for simulation of chemical and photochemical reactions under close-to-natural conditions
- laminar photochemical flow reactors for studies of gas-to-particle conversion and gas-particle interaction
- a flow tube cell with chemical ionization mass spectrometry detection for studies of gas-phase radical and heterogeneous reactions relevant to photo-oxidant and aerosol studies.

The chamber facilities are used in combination with a variety of advanced analytical techniques, chromatographic and spectroscopic, available in the Institute.

The Unit has the know-how and high-tech instrumentation to study physiological aspects of vegetation-atmosphere trace-gas exchange in controlled conditions in a greenhouse laboratory and in field campaign facilities:

- a system of six tree-exposure chambers designed as dynamic continuously stirred tank reactors (CSTR), installed in a temperature-controlled greenhouse, to analyse tree canopy-atmosphere interactions (e.g. biogenic emission, air pollutant deposition, transpiration, photosynthesis)
- a similar system of smaller cuvettes is installed in a controlled environment chamber suited to simulating extreme conditions (radiation, temperature, humidity, drought) for the study of plant physiology and gas-exchange
- a mobile off-road laboratory equipped for gas-exchange measurements of plants and plant canopies, including a portable CSTR system with control of atmospheric turbulence and of air temperature in mobile Teflon enclosures of various forms and volumes; the system is used to analyse gas exchange at the individual source level, e.g. branches, shrubs, soils
- additional field instrumentation, including a canopy analyser and an image analysis system to characterize radiative properties and leaf areas of plants and canopies; a relaxed-eddy-accumulation system is used to measure canopy fluxes of terpenoids and an eddy-correlation system is used for determining fluxes of carbon dioxide and water vapour.

The Laser Laboratory for Atmospheric Studies has developed laser-based spectroscopic methods for the analysis of trace elements at sub-femtogram level ($< 10^{-15}$ g). Special variants of the fluorescence and ionization methods, using two or three laser beams, have been tested, and an instrument based on laser ionization mass spectrometry, capable of characterizing single aerosol particles, has been constructed.

www.ei.jrc.it/ap/facilities

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SOIL, WATER, WASTE
LEVELS & FATES OF CHEMICALS

THE UNIT'S MISSION

The mission of the Soil, Water, Waste (SWW) Unit is to understand processes that occur in the aquatic and terrestrial environment, and to monitor and to control activities that affect the beneficial use of soil and water resources.

FIELDS OF ACTIVITY

The SWW Unit does applied research and peri-normative studies in the aquatic and terrestrial environment. The Unit supports the European Environmental Policy in general and the tasks of the European Environmental Agency (EEA) in particular. The main fields of activity are:

- harmonization and development of analytical methods
- water quality in coastal watersheds
- water management of lakes
- water re-use technology
- contaminated sites.

Homepage: www.ei.jrc.it/sww/intro

MAJOR ACHIEVEMENTS IN 1997

- A collaborative agreement with the Lombardia Region (I) was established with the aim of setting up instruments and methods for the management of water resources.
- Campaigns for characterization of the Mekong delta coastal zone in Vietnam, the Pearl River estuary in China and the Danube River estuary in Romania were organized and carried out.
- The characterization of two industrial contaminated sites: Portoscuso in Sardinia and Milazzo in Sicily (I).
- Bids for third-party work (TPW), competitive activities and shared-cost actions (SCA) amounting to 1.8 and 0.6 million ECUs, respectively, were obtained.

FUTURE ACTIVITIES

The fact that large areas of the European Union still suffer from water resources which are limited or of bad quality increased the demand from the Commission for support on water-quality improvement. This demand is reflected in the Unit's projects for some years. To consolidate the support for the Commission on water quality, the European Reference Laboratory for Water Pollution (LEPE: Laboratoire Européen de Pollution des Eaux) will be established. The main tasks of LEPE will be to improve the harmonization of and to develop new measurement methods, as well as to provide scientific and technical support for the definition and implementation of EU legislation on water quality.

The Unit will develop further activities on contaminated sites and coastal areas. An integrated methodology for the prediction of the ecological evolution of European coastal waters will be developed.

Harmonization and development of analytical methods

The research goals are in the context of comparability of environmental data:

- harmonization of existing analytical methods
- development of new analytical methods
- development of environmental reference materials.

Harmonization of analytical methods

A number of laboratory performance studies were organized in the context of the AQUACON-project and in co-operation with the PHARE Programme (DG I) to allow active participation of the Central and East European Accession Country laboratories. The series of interlaboratory exercises included: surface water for nutrient elements, simple ions and metals; rain water for simple ions, pH and conductivity; waste water for some parameters such as total organic carbon/dissolved organic carbon (TOC/DOC), adsorbable organohalogen compounds (AOX) and COD; metals in soil and sediments; polychlorinated biphenyls (PCBs) and other persistent organochlorine compounds in sediment, and mercury in fish and mussels. The laboratory participation varied between 70 and 220 laboratories per exercise.
www.ei.jrc.it/sww/projects/AQUACON

In the framework of TPW, exercises were organized for the public laboratories of the Piedmont Region for metals and volatile halogenated compounds in drinking water and phosphorus-organic pesticides in spinach.

The Comparative Evaluation of European Methods for sampling and sample preparation of soils (CEEM) project, financed by the Standards, Measurement and Testing Programme (DG XII), aims at the identification and quantification of soil-sampling uncertainty components in respect of metals. As was found in an AQUACON study on sea water sampling, sampling errors appear to be larger than errors in the final analysis. A test area known to be under metal stress from a nearby metal smelter has been characterized for several heavy metals. Fifteen laboratories, representing all the Member States, sampled the area on the basis of their own practices and standards, and one reference laboratory analysed all the samples, thus allowing sampling and analytical uncertainties to be distinguished. www.ei.jrc.it/sww/projects/CEEM

EUROMARKER

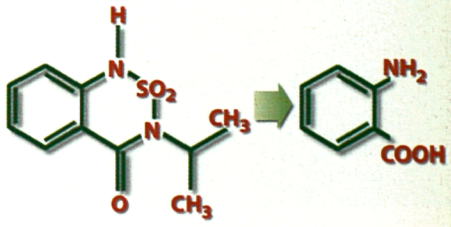
The goal of the perinormative project EUROMARKER (DG XXI) is to select a uniform marker for rebated gas oils and kerosene. The selected markers will be used throughout the EU to harmonize the prevention of illegal use of rebated fuels in car engines. The task of the Unit is to organize interlaboratory tests with custom laboratories in different Member States, thus investigating the applicability of different types of markers and the corresponding analytical methods in the different type of oils.
www.ei.jrc.it/sww/projects/EUROMARKER

Photodegradation of organic chemicals

A lack of photodegradation data has been identified for a number of organic chemicals mentioned in the priority lists of the EU Member States (Council Regulations EEC/793/93 and EEC/414/91). The project supports the European Chemicals Bureau (ECB), provides data on the rate and the products of photodegradation and the fate of these chemicals and their photodegradation products in the aquatic and terrestrial ecosystems, and assesses the potential phototoxicity. The innovative aspect of the project is that it will develop a standardized methodology, since a review of the liter-ature revealed that the experimental conditions in photodegradation studies differ very much, so the results are difficult to compare.

Selected Publications

- Bianchi, M., Zilli, D., Bortoli, A., Gerotto, M., Muntau, H.W. (1997). AQUACON-MedBas Project, Subproject No 2: Mercury in Food-chain. EUR Report 17695 EN.
- Mosello, R., Bianchi, M., Geiss, H., Marchetto, A., Serrini, G., Tartari, G., Muntau, H.W. (1997). AQUACON-MedBas Project, Subproject No 5: Freshwater Analysis Intercomparison 1/96. EUR Report 17347 EN.
- Nilsson, T., Ferrari, R., Facchetti, S. (1997). Inter-laboratory studies for the validation of solid-phase microextraction for the quantitative analysis of volatile organic compounds in aqueous samples. *Anal. Chim. Acta*, **356**:113-123.
- Rahman, M.S., Parreño, M., Bossi, R., Payá-Pérez, A.B., Larsen, B. (1998). Chlorobiphenyls in Sewage Sludge; Comparison of Extraction Methods. *Fresenius J. Anal. Chem.*, **360**:556-563.



Phototransformation of bentazone in 2-aminobenzoic acid as identified by LC-MS

Environmental reference materials

During 1997, four SCA activities financed by the SMT Programme (DG XII) were started:

- *Metals.* In the TRAMES project, the analytical procedures for the sequential fractionation of metals in sediment and the single-batch extraction of metals from soil have to be tested and finally backed by certified reference materials. At present, the candidate reference materials are undergoing homogeneity testing. www.ei.jrc.it/sww/projects/TRAMES
- *Phosphorus.* In the SEPHOS project, the most reliable phosphorus sequential-extraction procedures will be selected and at least one certified reference material for sediment and soil will be produced. At present, the test materials are ready for forthcoming exercises. www.ei.jrc.it/sww/projects/SEPHOS
- *Rare earth elements.* In the REE project, a candidate reference sediment for the analysis of rare earth elements material was produced in co-operation with the Institute for Reference Materials and Measurements (IRMM). www.ei.jrc.it/sww/projects/REE
- *EURO-Soils.* Several years ago, the five most abundant European soils (EURO-Soils) were identified, characterized and employed in a European-wide interlaboratory testing of the OECD Guideline 106 on the adsorption-desorption of chemicals in soil, in co-operation with DG XI. Although about a 100 kg of each soil had been produced, a remake was required and about 160 kg of each EURO-Soil were collected at the reference sites, processed according to the methodology applied to the first generation and satisfactorily tested. www.ei.jrc.it/sww/projects/EURO-Soils

Selected Publications

- Gawlik, B.M., Druges, M., Bianchi, M., Bortoli, A., Kettrup, A., Muntau, H.W. (1997). Tuna Fish (T-30) – a new Proficiency Testing Material for the Determination of As and Hg in Seafood, *Fresenius J. of Anal.Chem.*, **358**:441-445.
- Van Raaphorst, J.G., Quevauviller, Ph., Muntau, H.W. (1997). The Certification of the Mass Fraction of Chromium in Rye Gass (CRM 281), Beech Leaves (CRM 100), Aquatic Plant (CRM 596), Fly Ash (CRM 038) and Seawage Sludge (CRM 597). EUR Report 16840 EN.
- Quevauviller, Ph., Herzig, R., Muntau, H.W. (1997). The Certification of the Contents (Mass Fractions) of Al, As, Cd, Cr, Cu, Hg, Ni, Pb and Zn in Lichen, CRM 482. EUR Report 16841 EN.
- Quevauviller, Ph., Muntau, H.W., Fortunati, U., Vercoutere, K. (1997). The Certification of the Total Contents (Mass Fractions) of Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb and Zn and the Aqua Regia Soluble Contents (Mass Fractions) of Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb and Zn in a Calcareous Loam Soil, CRM 141R, in a Sewage Sludge from Domestic Origin, CRM 144R, and in a Sewage Sludge from Industrial Origin, CRM 146R. EUR Report 16890 EN, EUR Report 16891 EN, and EUR Report 16892 EN, respectively.

Water quality in coastal watersheds

The research goals are:

- to assess the potential changes in chemical delivery to coastal areas due to human intervention in regional hydrological regimes and global climate
- to improve methods estimating losses of pollutants from soil to water and from land to sea
- to investigate biogeochemical transformation of pollutants
- to characterize contaminated estuaries and coastal zones.

Adrian Leip (D) measuring emissions of the greenhouse gas N_2O (nitrous oxide) from coastal waters

Fate of nitrogen and pesticides in coastal watersheds

The catchment of a large subtidal lagoon located in the southern part of the River Po delta was chosen because it is representative of other agricultural and coastal areas in the Mediterranean region. The study area is characterized by the exchange of brackish water with the lagoon, fresh-water inflow from a branch of the River Po, and drainage of local pumping stations into the lagoon. The focus in 1997 was on experimental and modelling work on two scales: www.ei.jrc.it/sww/projects/Watershed

- Intensive measurements at the calibration sites. During the crop-growing season, data were gathered on land use, meteorology and concentrations of mineral nitrogen and pesticides in soil leachate. The measured data were used as a forcing function for the calibration of one-dimensional models (DAISY and PESTRAS) describing the transport of water and solute, heat transfer and transformation of nitrogen and pesticides during 1996-1997. In parallel, more detailed work on reaction flow transport processes through preferential flow paths in soil continued using a 3D-heterogeneous laboratory lysimeter. www.ei.jrc.it/sww/projects/UnsatSoils
- Upscaling of data. Methods for upscaling local data to regional level including the use of GIS technology and the distribution of the model outputs, were tested in a reference sub-basin. The upscaling will be calibrated over the grid of a hydrological model accounting for transport in the groundwater zone, surface runoff and channel flow (MIKE-SHE). In 1997, the hydrological model was calibrated against records of water levels and discharges to the lagoon.

The high nitrate supply and the amount of reducible organic substrate in the study area result in the production of greenhouse gases, in particular nitrous oxide (N_2O) and methane (CH_4). Nitrous oxide emissions from the lagoon were found to be lower during dystrophic crisis because of oxygen and nitrogen depletion, and higher during soil leaching periods in winter and after fertilization. www.ei.jrc.it/sww/projects/TraceGas

CHESS

The SCA-project CHESS (Climate, Hydrochemistry and Economics of Surface water Systems), which started in November 1997, investigates how expected changes in climate will affect the quality of freshwater resources in Europe and will develop a common modelling framework to be applied to a set of five catchments representing a transect of European climates. www.ei.jrc.it/CHESS

RICEOTOPES

The project Methane from rice paddies: isotopic signals, microbial pathways and fluxes (RICEOTOPES), which started in November 1997, will investigate the relationships between microbial pathways and observed isotopic ratios of C and H in atmospheric methane that is emitted from rice paddies.
www.ei.jrc.it/sww/projects/RICEOTOPES

Mekong River delta

In the frame of the EU-INternational COlaboration with Developing Countries (EU-INCO-DC), two sampling campaigns to characterize the Cuu-Long (Mekong River) delta and the adjacent coastal zone were organized by the Mobile Organic Analytical Laboratory. During the dry and the wet seasons, water, suspended particulate matter and sediment were sampled. The samples were analysed in Ispra for a wide range of organic compounds and trace metals.

Selected Publications

- Pettine, M., Martinotti, W., Tartari, G., Renoldi, M., Bianchi, M., Muntau, H.W. (1997). Contribution of the Lambro River to the Total Pollutant Transport in the Po Watershed (Italy). *Sci. Total Env.*, **192**:275-297.
- Premazzi, G., Cardoso, A.C. (1997). Inland water management: the limnological aspects. In: *Proc. Monitoring and Measurements of Lake Recipients*, 25-29 August 1997, Helsinki, Finland. John Wiley, *in press*.
- Andersen, B.L., Bidoglio, G., Leip, A., Rembges, D. (1997). Isotope Fractionation in Methane Reactions Studied by Gas Chromatography and Liquid Scintillation. *Appl. Radiat. Isot.*, **48**:501-509.

Water management of lakes

The research goals are:

- to develop cost-effective tools for monitoring the trophic states of European lakes
- to define instruments for the optimization of water-resource planning and management. www.ei.jrc.it/sww/projects/WaterManagement

SALMON

The SALMON-project (SAtellite remote sensing for Lake MONitoring) is designed to develop cost-effective satellite remote-sensing tools for monitoring environmental emergencies, such as algal blooms and trophic states of European lakes. This three-year project started in September 1996 and involves eight participants from Finland, Italy and Sweden as well as the SWW Unit. Three different European ecoregions are covered: sub-alpine, boreal and sub-arctic. The selected lakes in each of these ecoregions represent a major ecosystem and cover gradients of water components that are characteristic of several lakes in Europe. The SWW Unit is responsible for the acquisition of limnological data in the Italian sub-alpine region, namely in Lake Iseo and Lake Garda. www.ei.jrc.it/sww/projects/SALMON

Three sampling campaigns, two during the lake overturn in winter and one during the lake stratification in summer, were undertaken and planned in conjunction with the Istituto per lo Studio della Dinamica delle Grandi Masse (ISDGM), in Venice, and the Istituto per la Ricerca sul Rischio Sismico (IRRS), in Milan, both entities of the Consiglio Nazionale di Ricerca (CNR), to ensure the coincidence of the sampling and the overhead passage of the satellite. In parallel, laboratory experiments were carried out to compare the methods for the quantification of freshwater algal pigments (mainly total chlorophyll) and to intercompare the methods used by the participating laboratories. The data will give information on the water quality of the lakes and will serve as a control for the remote-sensing measurements.

Lake Iseo: TM image of the lake from September 1997 (SALMON project: elaborated by CMR-IRRS, Milan)

Lombardian Lakes

Two studies, established within the multiannual collaboration between the Lombardia Region (I) and JRC-EI, are directed at Lombardian lakes: one at Lake Iseo and another at the five largest lakes in the framework to safeguard Lombardia's surface and groundwater resources. The goal is to study limnological characteristics and to define instruments for the optimization of water-resource planning and management procedures, respectively.

Three pelagic stations, Zorzino (northern basin), Tavernola (maximum depth) and Iseo (southern basin), were investigated for physical, chemical and biological characteristics. Evaluation of the natural trophic level showed that the lake was originally oligotrophic, but, since the 1970s, it has become eutrophic. Investigation of the water-quality characteristics of the main tributaries showed that 37% of the total phosphorus load produced in the catchment basin ends up in the lake. The greatest contribution comes from the Province of Brescia. Point sources and discharges from cultivated and uncultivated lands appeared to be the main phosphorus sources, whereas animal husbandry was found to be only a minor source. The theoretical external phosphorus load was calculated using two methods with the phosphorus concentrations measured in 1982, 1987 and 1996, and different water residence times as input. The state of the art of all types of water-treatment plant was evaluated in two provinces, using the information provided by the Consorzio per la Tutela Ambientale del Sebino (1997) and the Water Clean-up Programmes of the Bergamo and Brescia Provinces (1994-96). The application of EVOLA models allowed preliminary conclusions to be drawn on the change of total-phosphorus concentrations as a result of different reduction scenarios for external loadings.

In the near future, water-quality objectives for the five largest lakes will be defined. The existing legislation and methods for assessment of the ecologically compatible flows and nutrient loadings, and water-quality classification schemes will be revised. The theoretical and residual nutrient loads in the five lakes will be determined and predictive models will be used to determine the compatible nutrient loads. The monitoring needs will be evaluated and a feasibility study for a lake observatory will be carried out. All the results will be finally combined in a thematic atlas, and Internet map servers and on-line models will be developed to make all the results available.

Basilicata Project

Activities in this two-year project were carried out as support to regional development through EC structural funding. The goal was to provide tools for efficient water management, to identify water-quality objectives for freshwater environments, to assess present trophic levels of water bodies, and to apply models for the identification of restoration management goals.

Water re-use technology

The research goal is:

- waste-water purification for irrigation purposes in agriculture.
  www.ei.jrc.it/sww/projects/WaterReuse

The studies on the possibility of recovering water for re-use from waste water and effluents from waste water depuration stations, under the TPW contract with Ente Autonomo del Flumendosa, continued. The removal of three pesticides belonging to the family of s-triazines, by catalysed photo-oxidation, was successfully studied on a laboratory pilot-plant scale, leading to undetectable residual pesticide concentrations in the processed water.

Effluents from the waste water depuration station "Is Arenas" in Cagliari (I) were studied by crossflow membrane filtration followed by catalysed photo-oxidation. The

quality of the waste water, based on disinfection and removal of organics, increased in such a way that the water is suitable for irrigation purposes; this is foreseen for the near future.

The MObile waste water treatment LABoratory (MOLAB), designed in 1996, was completed and tested using artificial waste water as well as true effluents and was found to reach performance levels comparable to those obtained in the laboratory pilot plants. The earlier designed experimental subsurface-flow reed bed testing facility was completed in 1997. The test modules allow the clean-up of industrial waste water of different origin and pollutant contents, in vertical and horizontal flow. Besides the greenhouse-based set-up described above, an open-air demonstration plant was constructed. The installation allows the testing of real waste water and would accommodate the "grey-water" cycle of a small condominium.

Contaminated sites

The research goal is:

- characterization of contaminated sites.

Portoscuso
The project was established on a TPW basis and is jointly run with the Ente Autonomo del Flumendosa. Its goal is to assess the present state of environmental contamination of the industrial area of Portoscuso in Sardinia and to design a monitoring station network.

Selected Publications

■ Coscera, G., Baglio, D., Skejó-Andresen, H., Payá-Pérez, A.B. (1998). Speciation of Organic Matter, Nitrogen and Phosphorus on Soils Irrigated with Industrial Wastewater. *Fresenius Environ. Bull., in press.*

Adriano Foti (l) working on subsurface-flow reed bed waste-water treatment testing facility

Selected Publications

■ Umlauf, G.C.K., Mano, S., Hiller, B., Barbiere, M., Facchetti, S. (1997). Recent Dioxine Levels in the "Bosco delle Querce". In: *Proceedings of the Convengo Chimica Uomo Ambiente*, Fondazione Lombardia per l'Ambiente e Regione Lombardia, 21-22 October 1996, Milano, *in press*.

Extensive sampling work, supported by the Mobile Inorganic Analytical Laboratory and the Environmental Reference Laboratory on Air Pollution (ERLAP), was performed in June 1997, considering air, atmospheric particulate matter, soil, surface and ground water, sediments and vegetation (vineyards and orchards). The first results show that, besides extensive soil contamination by lead, zinc, cadmium, arsenic and other metals, air particulates transport considerable amounts of these same metals, as well as fluorides.

Seveso

After the ICMESA accident in 1976, a monitoring programme was set up to follow the fate of polychlorinated dioxins and furans in soil and biota in the Seveso area. The Organic Analytical Laboratory is continuing its TPW activities in sampling, analysing and reporting the recent levels of contamination in the Lombardia Region. The data will be combined with epidemiological data and will be used for exposure assessments.

KNOW-HOW, INSTRUMENTS & LABORATORIES

The Unit's laboratories can perform analyses of organic and inorganic compounds at trace levels in all environmental matrices. Special attention is given to the determination of polychlorinated biphenyls (PCB), dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF), polynuclear aromatic hydrocarbons (PAH), volatile organic compounds (VOC), adsorbed organohalogen compounds (AOX), isotopic analysis of stable isotopes and major and minor elements in soil, sediment, water and waste material.

The Unit's laboratories have at their disposal a wide variety of analytical instruments, such as gas chromatographs coupled to low-resolution mass spectrometers with different ionization sources (GC-MS), liquid chromatographs (LC), capillary electrophoresis (CE), thermo-ion source and inductively coupled plasma mass spectrometers (ICP-MS), germanium-lithium, sodium iodide and liquid scintillation systems for counting beta (ß-) and gamma (γ-) radiation, a dual-energy gamma-ray scanner, and laser-based spectroscopic instruments.

Transport of compounds from point and non-point sources can be predicted in soil, surface and ground water by using hydrological models and laboratory and field data. The specialized laboratories of the Unit include:

- a clean room (class 100) for sample handling, preparation and measurement of contaminants at very low concentrations (< ng/kg level)
- a laboratory for the production of reference materials for environmental analysis, such as water, soils, sediments, biota and waste materials
- a limnological laboratory for aquatic ecology research and biological monitoring (phytoplankton biomass and density) of inland and marine waters; an axenic algal culture room is also available
- a geochemical laboratory equipped with anoxic chambers for simulation of variable redox conditions and a soil monolith facility for 3-D migration studies of organic compounds.

Advanced Mobile Analytical Laboratories (AMAL)

The Unit has three mobile analytical laboratories, the Mobile Inorganic Analytical Laboratory , the Mobile Organic Analytical Laboratory and the MObile waste-water treatment LABoratory, to carry out on-site soil, sediment and water analyses and waste-water treatment. They can be accompanied by a trailer which is equipped for microbiological analysis, two 32-kW generators, trailers for transportation of material and a four-wheel-drive truck for sampling purposes.

Mobile Inorganic Analytical Laboratory, equipped with a inductively coupled plasma mass spectrometer (ICP-MS) and an energy dispersive X-ray fluorescence spectrometer (EDXRF).

Mobile Organic Analytical Laboratory, equipped with basic laboratory instruments and with instrumentation for the on-site analysis of a wide range of organic contaminants in soil and water. The instrumentation for direct measurements consists of portable devices for soil gas characterization, such as an infrared/chemical detector for gases and a photo-ionization detector for the measurement of aromatic and chlorinated compounds as bulk parameters, a headspace GC using flame ionization and electron-capture detection for volatile organic compounds, immuno-assay equipment for the rapid on-site determination of different compound groups.
A six-port automated solid-phase extraction instrument and a high-intensity ultrasonic processor are used for water and soil extraction, respectively, and the extracts are measured by GC-MS. Analytical results are plotted on-site with a mapping programme.

Equipment for sampling marine water, suspended particulate and sediment, a large-volume pumping system, a 20-litre liquid/liquid extraction system, a flow-through centrifuge and a sediment corer are available. This box-based equipment can easily be shipped.

Sampling truck: a four-wheel-drive car is equipped for sampling of soil and water. The equipment consists of different percussion-drilling devices for soil and soil-gas sampling down to 4 m, bailer water samplers, time-series water sampler, pumps, well-logging probe for *in situ* measurement of temperature, pH, redox potential, electrical conductivity and dissolved oxygen, televiewer for down-hole inspection, probe for *in situ* measurement of natural and artificial gamma-emitting radionuclides, packers for the isolation of selected sections of boreholes, Global Positioning System, large-volume portable freezers and refrigerators.

MObile waste-water treatment LABoratory (MOLAB) allows treatment procedures for waste water to be developed in a pilot plant, which is based on cross-flow membrane separation of macromolecules and colloidal matter, and on photodegradation at semiconductor membranes. A compartment for on-site process control is present.

www.ei.jrc.it/sww/facilities

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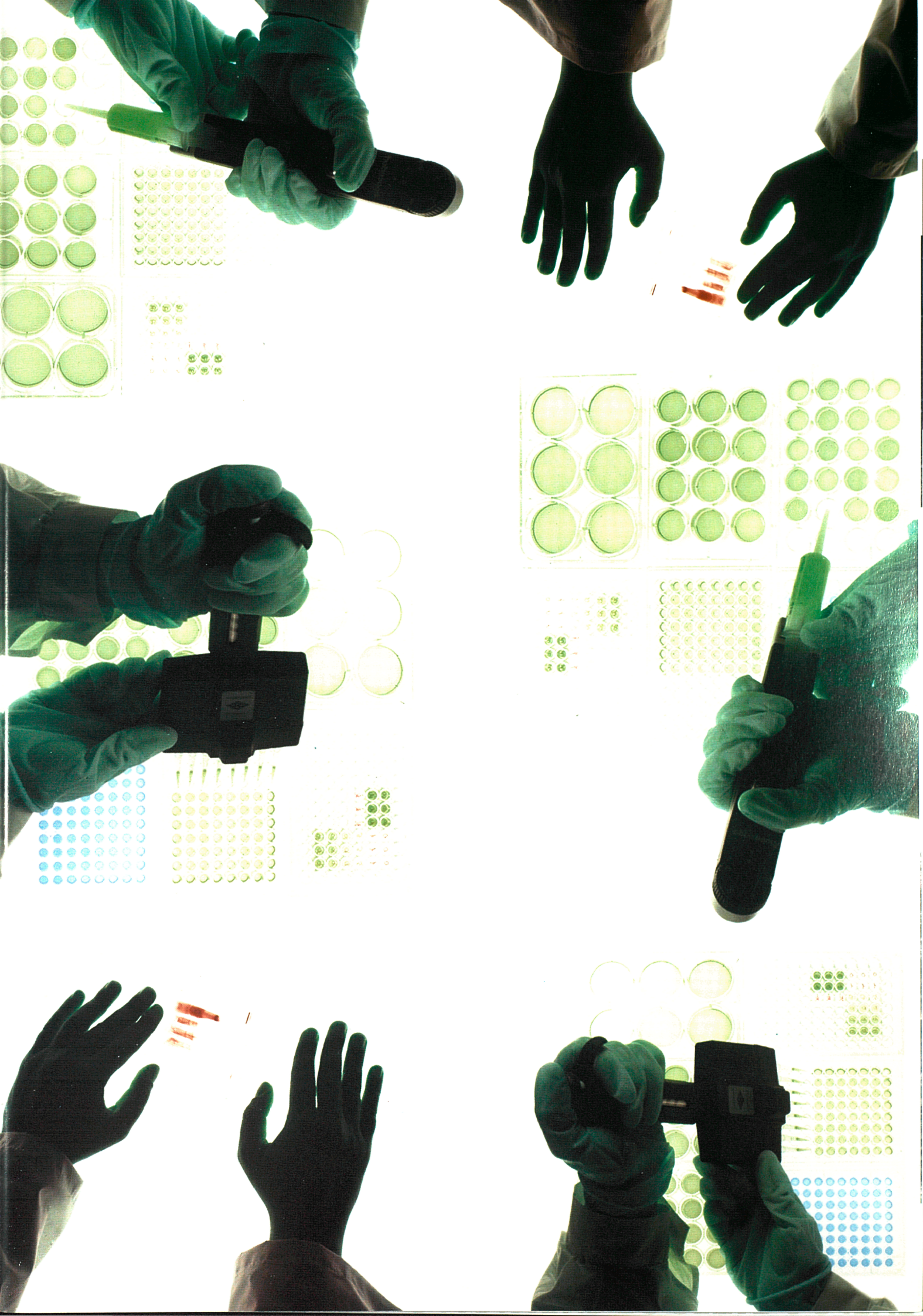
AMAL in action on a contaminated site



EXPOSURE TO CHEMICALS & THEIR EFFECTS

ECB: European Chemicals Bureau

Unit Head: **Gerald Vollmer**

ECVAM: European Centre for the Validation of Alternative Methods

Unit Head: **Michael Balls**

ETHH: Ecotoxicology & Human Health

Unit Head: **Peter Pärt**

ECB European Chemicals Bureau

EXPOSURE TO CHEMICALS & THEIR EFFECTS

THE UNIT'S MISSION

ECB provides support to the policy-making of DG XI and co-ordinates the scientific and technical implementation of European Union (EU) legislation on control of chemicals. This includes risk assessment and management of hazards posed by chemicals on the market within the EU.

FIELDS OF ACTIVITY

ECB's tasks are co-ordinated in 7 groups. The groups and the legislation involved are:

- Classification and Labelling of Dangerous Substances (Directive 67/548/EEC)
- New Chemicals (6th and 7th Amendment of Directive 67/548/EEC and Directive 93/67/EEC)
- Test Methods (Annex V of Directive 67/548/EEC)
- Existing Chemicals (Council Regulation (EEC)793/93)
- Export/Import (Council Regulation (EEC)2455/92)
- Pesticides (Directive 91/414/EEC)
- Biocides (Directive 98/XX/EC).

Co-ordination

A major ECB task is to co-ordinate the work on the different directives at the European level. To reach this goal, ECB organizes meetings for the national authorities of the Member States; it prepares the meetings, chairing or co-chairing them with DG XI, and writing the minutes and follow-up actions of these meetings. Furthermore, issues needing special attention may be discussed in working groups for which ECB plays a similar lead role. This ensures a harmonized approach to implementation and development of EU policy on commercial industrial chemicals.

Data security

Most of the information on the chemicals includes confidential details; the ECB therefore has a secure area for the paper archive and the computer systems, to which only authorized personnel have access. The computer system in this area has no connection to any outside computer or telecommunication network.

Homepage: www.ei.jrc.it/ecb/intro

MAJOR ACHIEVEMENTS IN 1997

- ECB organized 35 expert meetings and supported 5 workshops.
- IUCLID (International Uniform Chemical Information Database) was distributed in 461 copies to industry, governmental authorities and universities. IUCLID is available to the public on a CD-ROM.
- A decision-support software, EUSES (European Uniform System for the Evaluation of Substances), was distributed in 176 copies. EUSES is available to the public on a CD-ROM.
- Major progress was made in the resolution of issues regarded as problematic by the new Member States (Finland, Sweden and Austria) under the Accession Treaty. In addition, the classification and labelling of approximately 500 substances, including about 40 pesticides, were agreed.
- The Risk Assessment (RA) programme for "existing substances" finalised a review of 10 RA reports and reviewed 31 reports in all.
- Test protocols to clarify potentialy carcinogenic properties of Man-Made Mineral Fibres (MMMF) were developed.
- Four new test methods (three for polymers and one for bioconcentration) are ready for introduction into Annex V of Directive 67/548/EEC.

- Seven test methods for assessing genetic toxicity were agreed and are ready for translation and, with the language versions agreed, introduction into Annex V.
- An on-line version of the European Database on Export and Import of dangerous chemicals (EDEXIM) was finalized, and is available to the public.
- Dossiers on 348 new substances and 178 updates of previous dossiers were received, checked and distributed to the Member States and Norway.

FUTURE ACTIVITIES

The work in the ECB has mainly been related to the Directive 67/548/EEC and this work will continue to be a core activity within the ECB. The experience gained in the past five years (the period that ECB has existed) will be the basis for expanding this work, improving the methodology for risk assessment and disseminating knowledge on chemicals and their evaluation. This work will also be the foundation of assistance to DGXI in the assessment of active substances used in plant-protection products (PPP) and biocidal products (BP).

ACTIVITIES & PROJECTS

Classification and labelling

This work-area is responsible for the classification and labelling of chemical substances regarded as dangerous under Directive 67/548/EEC which lays down the criteria for classification and labelling; its Annex I consists of a list of substances that have been classified and labelled according to these criteria. Changes or updates of Annex I and the criteria are discussed by Member States' representatives in meetings prepared, organized and chaired by ECB. Agreement reached in these meetings results in the adaptation to technical progress of the Directive. In 1997, 14 meetings were held, dealing with human-health issues, environmental issues, pesticides, or particular aspects of concern for the Member States.
www.ei.jrc.it/ecb/projects/ClassLabel

T Toxic
T+ Very Toxic

N Dangerous for the Environment

O Oxidizing

C Corrosive

Xi Irritant
Xn Harmful

E Explosive

F Highly Inflammable
F+ Extremely Inflammable

Under the Accession Treaty the new Member States could maintain higher standards, that is, more restrictive classification and labelling during a transitiol alperiod which will end by December 1998. The Commission has assumed the responsibility of ensuring that the possible inclusion of these higher standards into Community legislation is discussed, and agreement should be found before this deadline. These discussions, possibly leading to an amendment of Directive 67/548/EEC, are held at the ECB and, in 1997, led to settling a number of issues regarded as problematic for the new Member States.

The tasks also include classification and labelling of pesticides, many of which are either on the Priority List for Risk Assessment of pesticides or are notified as new active substances under Directive 91/414/EEC.

The work-area also comprises co-ordination of the discussions on the criteria for classification and labelling of dangerous substances, which addressed four main issues in 1997: criteria for the ozone layer, criteria for chronic toxicity, criteria for algal toxicity and criteria for the terrestrial environment. The discussions were closely co-ordinated with similar discussions in OECD (Organization for Economic Co-operation and Development).

New chemicals

This work-area covers exchange of confidential summary dossiers on new chemicals. These dossiers are sent to the ECB by national competent authorities (CAs) in Member States as required by Directive 67/548/EEC (amended by Directive 92/32/EEC). The staff responsible for this ensure quality assurance and the distribution of dossiers to

Selected Publications

- Rasmussen, K., Christ, G., Davis, J.B. (1997). Registration of Polymers according to Directive 67/548/EEC, accepted for publication in *Toxicological and Environmental Chemistry* (December 1997).
- Vollmer, G., Rasmussen, K., Christ, G., Nørager, O., Davis, J.B., Wielen, A.v.d., Haas, C., Fasey, A. (1998). Compilation of EINECS: Descriptions and Definitions used for Substances, Impurities and Mixtures. *Toxicological and Environmental Chemistry*, **65**:113-122.

CAs. In 1997, 348 new dossiers, 178 updates of old dossiers and 259 final proposals for classification and labelling were received. Associated responsibilities include maintenance and upgrading of a New Chemicals Database (NCD). Each dossier contains a risk assessment of the substance for which the work-area ensures a harmonized approach between new and existing substances. Regular meetings and working groups with Member States ensure co-ordination of the activities.

The amount of information to be supplied on a substance, i.e. the testing requirements, is increased when the amount of substance placed on the market is increased: 10 kg/year/manufacturer; 100 kg/year/manufacturer and 1,000 kg/year/manufacturer. Further toxicological and ecotoxicological testing may be required for amounts exceeding 100 tonnes and 1,000 tonnes.

The European Inventory of Existing Commercial Chemical Substances (EINECS) takes into account the fact that the definition of a new chemical is closely related to the definition of an existing one. Upon request, the work-area furnishes CAs with information on whether the substances can be regarded as listed in EINECS or on whether they should be notified to the CA as new chemical substances. EINECS is a list of 100,106 substances that were on the market in the European Communities (EC) between 1971 and 1981.

Test methods

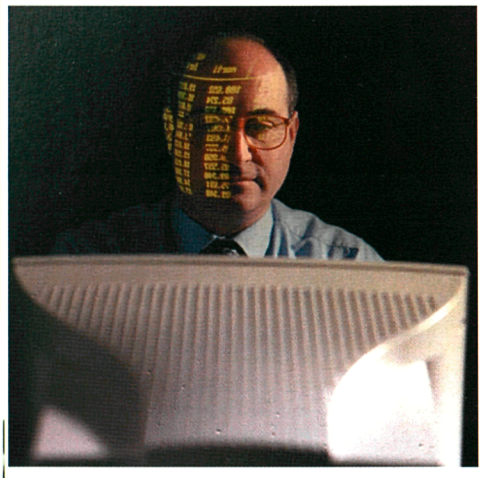
Selected Publications

- Marziano, N.C., Tortato, C., Sheikh-Osman, A.A., Riego, J.M., Zaldivar, J.M. (1997). The Problem of Acidity in Liquid and Solid Acid Catalysts: a Comparative Study by Protonation Equilibria of Weak Bases. *Organic Reactivity*, **31**:87-99.

The work-area is responsible for the technical/scientific work needed for the development, introduction and adaptation to technical progress of test methods of Annex V to Directive 67/548 (and its adaptations). www.ei.jrc.it/ecb/projects/TestingMethods

Annex V contains standardized test methods for the determination of the intrinsic properties of chemical substances. These methods allow the potential hazards of the substances for man and the environment to be characterized. The test results constitute the basis for a proper classification and labelling of chemicals and for risk characterization. In this sense, they play a central role in the EU policy on control of chemicals and they are referred to in many other pieces of EU legislation (e.g. those related to dangerous preparations, pesticides, cosmetics and biocides), which also refer to these methods.

Additionally, the use of these standardized methods ensures the mutual acceptance of data and free circulation of goods between different countries. Therefore, the activities in this work-area are co-ordinated with corresponding activities in the OECD and other international organizations.



Test methods: integration of comments to create the final test protocol

Presently, Annex V contains about 80 test methods which cover all areas of interest (physicochemical properties, human-health effects, environmental effects, ecotoxicity, and environmental fate). Since these methods do not cover sufficiently the requirements for notification of new chemicals, and given the continuous advance of scientific knowledge, around 40 test methods are currently under development or revision.

The work is carried out through consultation meetings with the EU national co-ordinators for test methods, national experts for each area of concern, and participation in the meetings and activities of OECD, UN and other international organizations on global harmonization.

During 1997 three additional protocols for test methods for Man-Made Mineral Fibres (MMMF) were developed and introduced into Annex V of the Directive. An additional 4 tests, three for polymers and one for bioconcentration, were finalized and are ready to be introduced into Annex V. Seven test methods for genetic toxicity have been agreed at the national co-ordinator level and are ready to be translated. A further four tests are under approval by the national co-ordinators.

Existing chemicals – Risk assessment

This work-area was set up within the ECB to carry out the scientific and technical duties of the European Commission as defined in Council Regulation (EEC) 793/93. The Regulation contains three basic elements: data collection, priority setting and risk assessment. Its aim is to set up a framework for systematic evaluation of the risk of "existing" chemicals (in general terms, an existing substance is a substance registered in EINECS) within the European Union (EU).
www.ei.jrc.it/ecb/projects/ExistingChemicals

A sub-set of 1,884 substances, so-called High-Production-Volume Chemicals (HPVCs) was extracted from EINECS. These substances were expected to be produced or imported at tonnages exceeding 1,000 tonnes per year per producer/importer, and are listed in Annex I of the Regulation. Producers and importers of substances produced/imported in such quantities are obliged to submit data sheets to the ECB.

A computer programme HEDSET (Harmonized Electronic Data Set) was developed for the data collection. The software is designed to run on standard PCs. Industry is obliged to use this programme for the compilation of the data sheets which they submit directly to the Commission (ECB). The data are sent to the security office at the Joint Research Centre (JRC) on diskettes and forwarded to the ECB. The ECB load the data into the IUCLID database which is the basic data source for priority setting and risk assessment. The priority setting ensures a systematic evaluation of the HPVCs.

A special priority-setting methodology, European Union Risk RAnking Method (EURAM), has been developed as a computer programme for the analysis of the data stored in IUCLID.

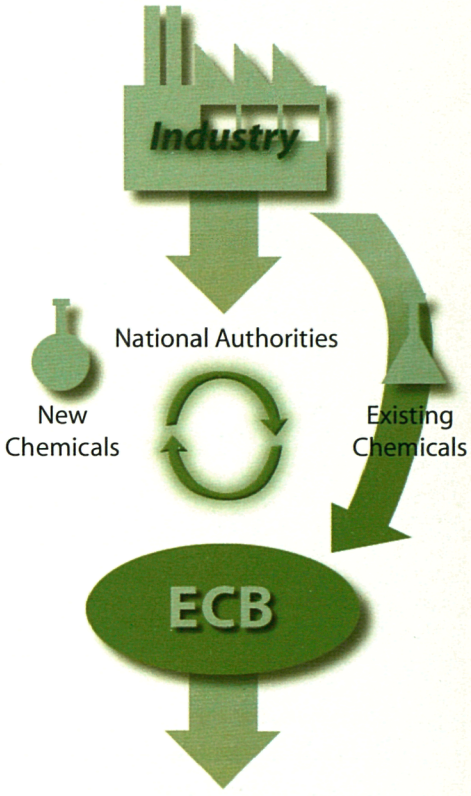
The programme, after consideration of certain limits to environmental and human-health effects for each substance based on the information in IUCLID, ranks substances by degree of concern. This ranking forms the basis of the first draft of a Commission proposal for a priority list. Each National Authority is given the responsibility for a sub-set of the priority substances and must carry out a risk assessment following the Commission regulation (EEC) 1488/94 and guidance given in the Technical Guidance Document on Risk Assessment for existing and new substances (TGD). The accepted final risk assessment report, drafted by the rapporteur Member State, and discussed in depth at the technical meetings with the other Member States and representatives of industry, is published as a summary report in the Official Journal of the European Communities and as the full report by the ECB. The full report, together with the validated data set the report is based on, will be included in IUCLID as well.

The non-confidential part of the IUCLID data is made accessible to interested users and, in 1997, an additional 500 copies of the non-confidential version of IUCLID were distributed.

The work-area participated in the GREATER (Geo-Referenced Regional Exposure Assessment Tool for European Rivers) project, which aims at providing much more detailed and accurate assessment of exposure of European rivers than the current TGD methodology does.

As support to the risk assessment, the EUSES software was further developed. It is a tool for carrying out all necessary calculations following the TGD on the preparation of the risk assessment. In 1997, 176 copies of EUSES were distributed.

Also in 1997, the review of 10 risk assessment reports was completed, and the review of 21 other reports was started. The conclusions from the first ten risk assessments are summarized below.



Classification and Labelling
Directive

ELINCS*
Directive

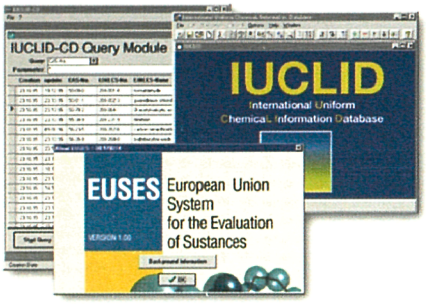
IUCLID**
CD-ROM

Export/Import Notifications
Countries

Risk Assessment
Regulation
Proposals for Action (DG XI)

*ELINCS
European LIst of Notified Chemical Substances

**IUCLID
International Uniform ChemicaLs Information Database



A risk assessment is done for human health (the human population, divided into consumers, workers and man exposed via environment) and for the environment (divided into air, soil, aquatic environment, sediment). There are three possible conclusions according to the Directive: conclusion (i) means that industry has to perform further tests and/or provide further information; conclusion (ii) indicates that at present the substance poses no unacceptable risk; and conclusion (iii) means that the risk reduction group under DG XI will recommend risk reduction measures to the relevant DGs which must take action.

The ten completed risk assessments provided the following conclusions:

There is a need for further information and/or testing – conclusion (i) – for the following substances with regard to environmental aspects:

- C10-13 chloro-alkanes: monitoring and toxicity test data in soil and sediment are required for the aquatic (sediment) and terrestrial ecosystems, e.g. the Koc value (partitioning coefficient between organic carbon and water).
- Cumene: chronic studies on *Daphnia* and algae are required for the aquatic environment.
- For trichlororethylene a risk was identified relating to the atmospheric degradation of the substance to dichloroacetic acid and environmental monitoring programmes in the aquatic environment and soil are required.

There is at present no need for further information and/or testing or for risk reduction measures beyond those which are being applied – conclusion (ii) – for the following substances:

With regard to human health aspects:
- C10-13 chloro-alkanes.
- Benzene.
- C10-13-alkyl derivatives.
- 4-chloro-2-methyl phenol.
- Cumene.
- 2-(2-butoxyethoxy)ethanol: no further information is required for man exposed via environment.
- Hydrogen fluoride: no further information is required for consumer exposure, 2-(2-methoxyethoxy)ethanol: no further information is required for man exposed via environment.

With regard to environmental aspects:
- 1,3-butadiene.
- 2-(2-butoxyethoxy)ethanol.
- 2-(2-methoxyethoxy)ethanol.
- Acrylamide.
- C10-13 chloro-alkanes, excluding the aquatic environment, terrestrial ecosystem and non-compartment-specific effects relevant to the food chain.
- Hydrogen fluoride, excluding the atmosphere.
- Trichloroethylene, excluding the atmosphere.
- Cumene, excluding the aquatic environment.

There is a need for limiting the risks: risk-reduction measures which are already being applied shall be taken into account – conclusion (iii) – for the following substances:

With regard to human health aspects:
- Acrylamide for workers, because of concern about potential central nervous system disturbances, mutagenicity and carcinogenicity, for consumers and man exposed via environment, because of concern about mutagenicity and carcinogenicity.
- 1,3-butadiene for workers, consumers and man exposured via environment, because of concern about mutagenicity and carcinogenicity.
- 2-(2-butoxyethoxy)ethanol for workers, because of concern about anticipated local and general systemic effects and for consumers, because of concern about anticipated local effects.
- Hydrogen fluoride for workers, because of concern about skin, eye and respiratory irritation and general systemic toxicity; and for man exposed via environment, because of concern about general systemic toxicity.
- 2-(2-methoxyethoxy)ethanol for workers, because of concern about general systemic and developmental effects as a consequence of repeated dermal exposure; and for consumers because of

concern about the use of paint or paint stripper containing this substance.
- Trichloroethylene for workers, because of concern about general systemic toxicity, potential central nervous system disturbances, mutagenicity and carcinogenicity; and for consumers and man exposed via environment, because of concern about mutagenicity and carcinogenicity.

With regard to environmental aspects:
- Hydrogen fluoride because of the emissions to atmosphere. Risk reduction strategies are currently under development to remove these risks.
- C10-13 chloro-alkanes, a risk for aquatic ecosystems was identified. Risk reduction strategies are currently under development to remove these risks.

Selected Publications

■ Berggren, E., Debois, M., Duffield, J., Janush, A. (1997). EDEXIM: the European Database on Export and Import of certain Dangerous Chemicals. *Environ. Sci. & Pollut. Res.*, **4**(1):55-59.

Export/import control

The work-area monitors the export and import of chemicals that are subject to restrictions in their use and applications under Council Regulation (EEC) 2455/92. In addition, the work-area ensures information exchange with the Member States, third countries, UNEP (United Nations Environment Programme) and FAO (Food and Agriculture Organization of the United Nations).

In this context, an on-line uniform database, EDEXIM, has been developed. A non-confidential version is available to national authorities outside the EU, interested organisations and industry. EDEXIM provides classification and labelling information for substances covered by the regulation, statistical routines, *ad hoc* data sheets for preparations and complete Prior Informed Consent (PIC) information. PIC is currently a voluntary procedure. The work-area participated in the negotiations organized by UNEP and FAO to transform PIC into a legally binding instrument. It is expected that the convention will be ready for signature in September 1998.

New activities in 1997

Plant protection products. The ECB, together with DG XI, is required to participate in the review programme of Plant Protection Products (PPP) under Directive 91/414/EEC regarding environmental aspects (DG VI is the responsible over all for the Directive). During 1997, the work-area participated in the expert meetings on environmental risk assessment. Furthermore, how the review process itself could be improved was discussed and a proposal for a more transparent and efficient review programme was made.

Biocides. The ECB started this activity to give support to the future directive on biocidal products, formerly known as non-agricultural pesticides. The work-area began the checking of the list of active substances provided by CEFIC used in such products. It participated in the discussion of the pre-drafts of the technical guidance documents which will support the day-to-day implementation of the directive once approved. The work-area participated in the working group set up by DG XI on human exposure scenarios (especially the consumers) for the 23 product types defined in the Directive, and in the steering committee charged with selecting a consultant to derive a model for concentrations of antifoulants in marine environments.

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KNOW-HOW, INSTRUMENTS & LABORATORIES

ECB is a centre of excellence and the focal point for assessment of the risk posed by chemicals. To support this activity several data bases containing information on chemicals have been developed. As far as possible they have been made available to the public, IUCLID in a CD-ROM version and EDEXIM in an on-line version. Furthermore, the tool developed to assist risk assessment according to the technical guidance documents is also available to the public as the EUSES CD-ROM.

www.ei.jrc.it/ecb/facilities

ECVAM

European Centre for the Validation of Alternative Methods

EXPOSURE TO CHEMICALS & THEIR EFFECTS

THE UNIT'S MISSION

ECVAM seeks to promote the scientific and regulatory acceptance of alternative (i.e. non-animal) methods which are of importance to the biosciences and which reduce, refine or replace the use of laboratory animals. The Unit was established to:

- co-ordinate the validation of alternative test methods at the European Union level
- act as a focal point for the exchange of information on the development of alternative test methods
- establish, maintain and manage a database on alternative procedures
- promote dialogue among legislators, industries, biomedical scientists, consumer organizations and animal welfare groups, with a view to the development, validation and international recognition of alternative test methods.

FIELDS OF ACTIVITY

ECVAM provides scientific and technical support to other Commission services, primarily in relation to Directive 86/609/EEC on the protection of animals used for experimental and other scientific purposes. The Unit is a source of detailed and expert information on the development, prevalidation, formal validation, and scientific and regulatory acceptance of non-animal tests and testing strategies.

Validation is the process whereby the reliability and relevance of a procedure are established for a particular purpose. It typically involves testing coded materials according to an identical protocol in several independent laboratories.

ECVAM's principal activity is to facilitate, co-ordinate and participate in validation activities at the EU level, through the design and management of international inter-laboratory prevalidation and formal validation studies . ECVAM's other main fields of activity relate to:

- exchange of information through the organization of workshops and meetings
- establishment and management of a database on alternative methods
- laboratory work concerned with the evaluation and prevalidation of *in vitro* tests.

Homepage: www.ei.jrc.it/ecvam/intro

MAJOR ACHIEVEMENTS IN 1997

- Phototoxicity – the second phase of an EU/COLIPA (The European Cosmetic, Toiletry and Perfumery Association) international validation study was successfully completed, and the scientific validity of the 3T3 neutral red uptake phototoxicity (NRU PT) test was endorsed by ECVAM's Scientific Advisory Committee.
- Skin corrosivity – an international validation study co-ordinated by ECVAM was successfully completed, and two tests (a commercially available human skin model, EPISKIN™, and the rat skin transcutaneous electrical resistance assay) were judged to have been scientifically validated.
- Embryotoxicity – an international prevalidation study on three in vitro methods (the micromass, whole rat embryo and embryonic stem cell line assays) was completed.
- Haematotoxicity – an international prevalidation study on the granulocyte-macrophage - colony-forming unit (GM-CFU) test for acute neutropenia was initiated.
- Eye irritation – ECVAM participated in phases 2 and 3 of a prevalidation study on the fluorescein leakage test.
- Vaccines – several international studies on *in vitro* methods for vaccine potency and safety testing were initiated.

Selected Publications

■ Fentem, J.H., Balls, M. (1997). The ECVAM Approach to Validation. In: (Zutphen, L.F.M. van, Balls, M., eds.) *Animal Alternatives, Welfare and Ethics. Proceedings of the 2nd World Congress on Alternatives and Animal Use in the Life Sciences*, Utrecht, The Netherlands, 20-24 October 1996. *Developments in Animal and Veterinary Sciences*, **27**:1083-1089. Elsevier, Amsterdam (NL).

- Percutaneous absorption – support was provided for the OECD Secretariat in relation to the general acceptance of an in vitro test guideline by all OECD Member Countries.
- Monoclonal antibody production – the recommendation from ECVAM workshop report 23 that a validated *in vitro* method be used in place of the *in vivo* ascites method for the production of monoclonal antibodies stimulated activity by various groups in Europe and the USA.
- Database – work continued on the establishment of ECVAM's unique databases on alternative methods and on validation studies (dbVas-online), including a feasibility study on the assessment and entry of data for specific toxic effects.
- Workshops – five ECVAM workshops were held, and the reports of five workshops and one ECVAM task force were published.
- Publications – 25 articles by ECVAM staff were published in the scientific literature.

FUTURE ACTIVITIES

Prevalidation and validation studies will continue in the areas of embryotoxicity, haematotoxicity and vaccine testing. Prevalidation studies will be initiated for skin irritation testing and on selected *in vitro* methods for the blood-brain barrier. There will be various follow-up activities to the successful validation studies completed in 1997, including the preparation of test guidelines on alternative methods for photo-toxicity and skin corrosivity testing. Working groups on validation studies, bench-marking, and testing strategies will be established, to define short-term strategies for replacing the Draize eye-irritation test. Work will begin on the evaluation of an *in vitro* method for screening for potential sensitisers/allergens. All of the information on the validation studies in which ECVAM has been involved will be loaded into dbVas-online. Eleven workshops are planned, including ones on progress made with the validation of alternative tests, reduction of animal use in regulatory testing, the use of human tissues, and eye-irritation testing.

ACTIVITIES & PROJECTS

Validation studies

ECVAM's main validation activities in 1997 involved two international studies:

- Completion of the formal validation phase of an EU/COLIPA study on an *in vitro* phototoxicity test.
- A validation study on *in vitro* tests for skin corrosivity.

At its 9th meeting, on 1-2 October 1997, the ECVAM Scientific Advisory Committee unanimously endorsed the outcome of the phototoxicity validation study, agreeing with the conclusion of the Management Team that "the 3T3 NRU PT test is a scientifically validated test which is ready to be considered for regulatory acceptance".

The main objectives of the validation study on *in vitro* tests for skin corrosivity were: to identify tests capable of discriminating corrosives from non-corrosives for selected types of chemicals or all chemicals, and to determine whether these tests could correctly identify known R35 (UN packing group I) and R34 (UN packing groups II & III) chemicals. The tests evaluated were the rat skin transcutaneous electrical resistance (TER) assay, CORROSITEX™ (a commercially available physico-chemical test for corrosivity), the Skin2™ ZK1350 corrosivity test (a commercially available human skin model) and EPISKIN™. Each test was conducted in three independent laboratories, and sixty coded chemicals were tested. Two of the tests, the TER assay and EPISKIN, met the criteria agreed by the Management Team for them to be considered scientifically validated for use as replacements for the animal test for distinguishing between corrosive and non-corrosive chemicals. EPISKIN was the only test able to distinguish between known R35 and R34 chemicals.

Liquid-nitrogen cellular storage room at ECVAM; different cell lines are kept frozen under liquid nitrogen until they are required for experiments

Selected Publications

■ Leahy, D.E., Duncan, R., Ahr, H.J., Bayliss, M.K., De Boer, A.G., Darvas, F., Fentem, J.H., Fry, J.R., Hopkins, R., Houston, J.B., Karlsson, J., Kedderis, G.L., Pratten, M.K., Prieto, P., Smith, D.A., Straughan, D.W. (1997). Pharmacokinetics in Early Drug Research. The Report and Recommendations of ECVAM Workshop 22. *Alternatives to Laboratory Animals*, **25**:17-31.

In vitro *nephrotoxicity studies measurement of the trans-epithelial resistance of kidney epithelial cells, to determine the effects of chemicals on barrier function*

Selected Publications

■ Janusch, A., Van Der Kamp, M.D.O., Bottrill, K., Grune, B., Anderson, D.C., Ekwall, B., Howald, M., Kolar, R., Kuiper, H.J.D., Larson, J., Loprieno, G., Sauer, U.G., Smith, A.J., Van Der Valk, J.B.F. (1997). Current Status and Future Developments of Databases on Alternative Methods. The Report and Recommendations of ECVAM Workshop 25. *Alternatives to Laboratory Animals*, **25**:411-422.

Selected Publications

■ Archer, G.E.B., Balls, M., Bruner, L.H., Curren, R.D., Fentem, J.H., Holzhütter, H.-G., Liebsch, M., Lovell, D.P., Southee, J.A. (1997). The Validation of Toxicological Prediction Models. *Alternatives to Laboratory Animals*, **25**:505-516.

In addition, prevalidation and validation studies are ongoing in the areas of embryotoxicity testing, haematotoxicity testing, and vaccine potency and safety testing. www.ei.jrc.it/ecvam/projects/ValidationStudies

Workshops and task forces

One of ECVAM's priorities is to ensure that it is well informed about the state of the art of non-animal test development and validation. ECVAM workshops are therefore held to review the current status of various types of alternative tests and their potential uses, and to identify the best ways forward. The reports and recommendations of ECVAM workshops are published in international scientific journals. During 1997, five workshops were held, on:

- The Use of Transgenic Animals in the European Union.
- Issues Relating to the Release of Proprietary Information and Data for Use in the Validation of Alternative Methods.
- Non-animal (Alternative) Tests for Evaluating the Toxicity of Solid Xenobiotics.
- The Use of Human Keratinocytes and Human Skin Models for Predicting Skin Irritation.
- Validation of Alternative Methods for the Potency Testing of Immunobiologicals.

ECVAM Task Forces have been established on topics of importance to ECVAM (for example, on biostatistics, prevalidation, skin irritation, and developmental toxicity), to focus on more specific issues, such as the actual design of prevalidation or validation studies. www.ei.jrc.it/ecvam/projects/WorkSympos

Information services

ECVAM's Scientific Information Service (SIS) primarily focuses on the following:

- A database on alternative methods, their uses, and their state of development and validation, encompassing details of the methods, chemicals tested, results obtained, and literature references.
- A database on validation studies (dbVas-online), which provides support for ECVAM's validation studies and includes information on participating organizations, test protocols and prediction models, test chemicals, results obtained, and follow-up activities. Access to dbVas-online will be via the Internet (general access) and Intranet (access restricted to participants in on-going validation studies).

A third database on *in vitro* pharmacotoxicology laboratories is at the planning stage. www.ei.jrc.it/ecvam/projects/SIS

Biostatistics

The validation of new test methods, in terms of assessing their relevance and reliability, requires the application of biostatistical methods. Close collaboration between biostatisticians and experimental toxicologists is essential during the development and subsequent validation of alternative methods. ECVAM's biostatistician played a key role during the successful validation study on *in vitro* tests for skin corrosivity, having input into the study design and being responsible for the data collection and analysis stages. The ECVAM Biostatistics Task Force continues to develop and evaluate new ideas for improving the analysis of data obtained from alternative tests during validation studies, through the proper application of biostatistical techniques. In particular, the importance of developing and assessing prediction models, for interpreting the data obtained with alternative methods in relation to known *in vivo* effects, was demonstrated during 1997. www.ei.jrc.it/ecvam/projects/Biostatistics

Laboratory studies

Collaborative experimental studies with groups in the EU Member States, focusing on the evaluation and prevalidation of new *in vitro* tests, are being undertaken in the following areas:

- *Embryotoxicity testing* in vitro *with embryonal stem cell lines.* This project has two aspects: the characterization of native and engineered embryonal stem cell lines for the development of more specific and more sensitive endpoints for embryotoxicity, and participation in collaborative prevalidation and validation studies.
- *Haematotoxicity testing* in vitro. The laboratory studies being conducted involve participation in a prevalidation study on GM-CFU assays for predicting acute neutropenia, and comparative investigations with human bone marrow and cord blood cells.
- *Characterization and use of genetically engineered cell lines for studies of metabolism-mediated toxicity.* This project involves characterization, and evaluation of the applicability, of various genetically engineered mammalian cell lines expressing human cytochrome P450 isoforms.
- *Identification and evaluation of new endpoints for use in an* in vitro *nephrotoxicity screening test.* The integrity of renal epithelial cells grown on microporous supports following exposure to chemicals is being assessed by measuring several markers of epithelial barrier function.
- *Development of genetically manipulated neuronal cell lines for evaluation of the cytotoxic effects of drugs by using apoptosis (programmed cell death) as a molecular endpoint.* Genes known to drive or inhibit apoptosis (p53 and bcl-2) are being introduced into neuronal cell lines of interest for neurotoxicity testing.

www.ei.jrc.it/ecvam/projects/LaboratoryStudies

Other projects

Three other major projects are being undertaken in collaboration with scientists in the EU Member States, on:

- Scientific, ethical and legal aspects of the production, breeding and use of transgenic animals.
- The use of human volunteers in assessing the efficacy and safety of cosmetic products.
- The use of mathematical models in the development and validation of non-animal tests and testing strategies.

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Selected Publications

■ Balls, M. (1997). The Three Rs Concept of Alternatives to Animal Experimentation. In: (Zutphen, L.F.M. van, Balls, M., eds.) *Animal Alternatives, Welfare and Ethics. Proceedings of the 2nd World Congress on Alternatives and Animal Use in the Life Sciences*, Utrecht, The Netherlands, 20-24 October 1996. *Developments in Animal and Veterinary Sciences*, **27**:27-41. Elsevier, Amsterdam (NL).

KNOW-HOW, INSTRUMENTS & LABORATORIES

ECVAM is now firmly established as the leading international centre for co-ordinating the validation of alternative methods.

It is a source of expert advice on: theoretical and practical aspects of the validation of new tests, the current status of alternative methods for use in toxicology and the biosciences in general, *in vitro* tests for embryotoxicity, haematotoxicity, metabolism-mediated toxicity and nephrotoxicity, and general animal welfare issues (scientific and ethical), such as the use of transgenic animals.

ECVAM's purpose-built, multi-disciplinary, laboratory facilities are equipped to undertake cell and tissue culture, general biochemical analyses, analytical chemistry and toxicology, and molecular biology studies. They include a modern flow cytometer, which is in great demand for the haematotoxicity and embryotoxicity studies in progress.

www.ei.jrc.it/ecvam/facilities

Selected Publications

■ Fentem, J.H., Balls, M. (1997). Application of the Three Rs in Toxicology. *Comments on Toxicology*, **6**(1):5-20.

■ Straughan, D.W., Fentem, J.H., Balls, M. (1997). Replacement Alternative and Complementary *In Vitro* Methods in Pharmaceutical Research. pp. 1-13 in: (Castell, J.V., Gómez-Lechón, M.J., eds.) In Vitro *Methods in Pharmaceutical Research*. Academic Press, London (UK).

ETHH

Ecotoxicology & Human Health

EXPOSURE TO CHEMICALS & THEIR EFFECTS

THE UNIT'S MISSION

A new Unit, Ecotoxicology and Human Health, including the former Indoor Air and Life Science units, was set up with the aim of reorienting the activities towards the 5th Framework Programme (FWP).

The Unit's role is to carry out pre-normative and applied research for use in the design and implementation of the European Environmental Policy. In particular, work is devoted to the area of human and environmental toxicology, focusing on the mechanisms by which environmental contaminants affect living organisms.

FIELDS OF ACTIVITY

Research is focused on selected aspects of chemical and microbiological pollution. The Unit will work on an integrated methodological approach to the assessment of exposure to and effects of environmental pollutants. The Unit's work places a particular emphasis on:

- assessment of the impact of exposure to chemicals and pathogens in water, by means of aquatic toxicology and molecular biology methods
- evaluation of the endocrine-disrupting activity of environmental pollutants
- identification of molecular targets and biomarkers for the evaluation of exposure and effects of environmental chemicals
- development of molecular biological screening methods for pathogens in water
- evaluation of the impact of environmental factors on age-related degenerative disorders.

In the field of indoor pollution, aspects of exposure/risk identification/assessment and pollution control are also included.

- Management and scientific secretariat of the European Collaborative Action Indoor Air Quality & Its Impact on Man (ECA-IAQ).
- Research aimed at reducing indoor pollution by volatile organic compounds (VOCs), including the identification, characterization and control of indoor pollution sources using/developing small and large environmental test chambers and advanced analytical techniques.
- Assessment of indoor pollution by low- or non-volatile organic compounds and evaluation of their biological activity/health relevance.

Homepage: www.ei.jrc.it/ethh/intro

MAJOR ACHIEVEMENTS IN 1997

EI contributions to the VOCEM (Volatile Organic Compound EMissions) project comprised:

- Measurement of the dependency of VOC emissions from various materials on the surface air velocity, using a new test chamber with controlled air velocity; the dependency is strongest for thin-film sources such as paints, and turbulence plays a minor role.
- Organization of two analytical intercomparison experiments to improve the analytical performance of the laboratories participating in the final VOCEM intercomparison experiment. A core group of 12 laboratories succeeded in reducing interlaboratory standard deviations of chemical analysis down to less than 20%, compared to values ranging from 25-300% at previous similar intercomparisons.

- A patent application to the European Patent Office for the automatic air-pollution analyser developed at the EI for indoor and workplace applications passed the International Preliminary Examination phase and the national phases were started. To exploit this technology, a contract was granted by DG XIII under the competitive support scheme for construction of a commercial version of the analyser.
- ECA-IAQ celebrated 10 years of fruitful work. Two new reports were published: *Evaluation of VOCs emissions from building products-solid flooring materials*, offering a labelling procedure for flooring materials and awaited by industry; and *Total volatile organic compounds (TVOC) in indoor air quality investigations*. ECA-IAQ working groups prepared draft reports on sensory evaluation of environmental quality and on risk assessment in buildings.
- Experiments in the Indoortron chamber showed that up to 85% of VOCs emitted into indoor environments may not be vented but sorbed onto indoor surface materials, thus showing that emissions from consumer products may, through a sorption/desorption process, lead to "secondary" emissions of indoor surface materials that are suspected of contributing substantially to indoor exposures.
- A new flexible method for producing atmospheres with controlled low concentrations of VOC mixtures was developed for sorption studies in small and large test chambers.
- A screening method using two microchambers (FLECs) was set up to study simultaneously the uptake and transport of VOCs by and through indoor materials.
- In collaboration with the University of Ioannina, data on the organic content of house dust in Greece were collected, confirming the common features detected earlier in Italy.
- Research on the immunotoxicity and neurotoxicity of metals was carried out under two DG XII-D SCA projects (Environment programme, Risks to human health area). The sensitivity of a human keratinocyte cell line (HaCaT) to nickel chloride was determined by cytotoxicological, protein chemistry and molecular biology methods. In collaboration with the Universities of Pavia and Parma, a multifactorial screening in neural cell models (PC12, cerebellar granule cells) was adopted to establish appropriate dose-response curves and exposure conditions in *in vitro* neurotoxicity experiments.
- The study of inhibitory effects and mechanisms of action of trace metals on the key AIDS enzyme HIV-1 reverse transcriptase was completed and reported.
- An SCA was awarded under the Environment and Climate Programme to evaluate the endocrine-disrupting activity of environmental pollutants (EDAEP).
- Research was completed within the EURO TERVIHT (Trace Element Reference Values In Human Tissues) project on basic levels of trace metals in the European population; in particular, the Danish, Spanish and British campaigns were completed and reported.
- Activities on endocrine disruptors in feral fish and on the development of molecular biological methods for the detection of *Cryptosporidium* in water resources have been initiated.
- Collaboration with the International Programme on Chemical Safety for the global inventory of research on endocrine disruptors.

Selected Publications

- Schlitt, H. (1997). Impinger sampling coupled to high performance liquid chromatography by a modified autoinjector interface. *Journal of Chromatography A*, **762**:187-192.
- Schlitt, H. (1997). A new device for the automatic determination of formaldehyde in air. *Gefahrstoffe – Reinhaltung der Luft*, **57**:75-78.
- ECA-IAQ (European Collaborative Action "Indoor Air Quality and Its Impact on Man"). (1997). Report No 18: Evaluation of VOC Emission from Building Products-Solid Flooring Materials. EUR Report 17334 EN.
- ECA-IAQ (European Collaborative Action "Indoor Air Quality and Its Impact on Man"). (1997). Report No 19: Total Volatile Organic Compounds (TVOC) in Indoor Air Quality Investigations. EUR Report 17675 EN.
- Iversen, B.S., Mennè, C., White, M.A., Kristiansen, J., Christensen, J.M., Sabbioni, E. (1998). Inductively coupled plasma mass spectrometry determination of molybdenum in urine from a Danish population. *The Analyst*, **123**(1):81-85.
- Iversen, B.S., Panayi, A., Camblor, J.P., Sabbioni, E. (1996). Simultaneous Determination of Co and Mn in Urine by ETAAS. Method Development Using a Simplex Optimization Approach. *Journal of Analytical Atomic Spectrometry*, **11**(8):591-599.

FUTURE ACTIVITIES

The focus of future activities will be the development of biomarkers as indicators of individual exposure to environmental agents and of *in vitro* tests as indicators of their biological activity or effects, with emphasis on mixtures and mixed exposures. Ancillary instruments, such as quantitative structure-activity relationships (QSAR) and data bases, will be used. A multidisciplinary approach, including molecular biology-based methods, will be established to support the re-evaluation of criteria for ecological water quality and for the assessment of human exposure.

Special attention will be paid to:

Water quality: development of aquatic ecotoxicology by the use of specific molecular biology techniques to assess biological contamination of water sources as well as the exposure and effects of chemicals in the aquatic environment.

Endocrine disruptors: definition of a strategic approach in support of actions aimed at detecting putative endocrine-disrupting activities of environmental pollutants present in water, food and air mixtures.

Exposure to chemical mixtures: establishment of methods to assess the exposure and risk arising from complex exposure situations, such as chemical mixtures and mixed/combined exposure (indoor/outdoor air, water/food, etc.), including the preparation of well characterized environmental or artificial mixtures relevant to human exposure for the evaluation of biological test assays.

Identification and assessment of environmental factors, which may increase the risk to develop age-related degenerative diseases: identification of molecular biomarkers to recognize sub-clinical states and early manifestations of the disease, to be carried out with collaborating Institutions.

ECA-IAQ: significance of indoor air quality for human health in the context of energy use in buildings and urban life. Final drafts of reports on risk assessment in buildings and sensory evaluation of indoor environmental quality will be completed. The labelling procedure for solid flooring materials will be updated and extended to other building materials.

VOCEM project: the EI will test a procedure for minimizing chamber sink effects and will conduct the third European interlaboratory comparison for validating the improved VOC emission procedure.

Interaction of VOCs with indoor materials: particular attention will be devoted to the sorption capacity of materials and to modelling, including diffusion processes.

ECA-IAQ

(European Collaborative Action – Indoor Air Quality & Its Impact on Man)

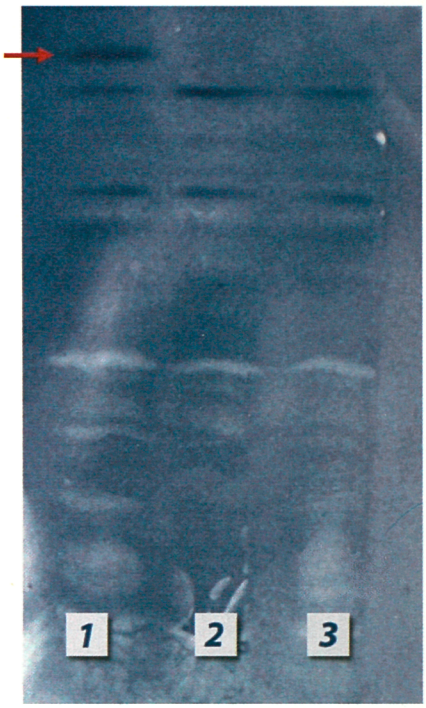
Since 1987, the ECA-IAQ organizes the collaboration of leading experts from 15 European countries, and the EI provides support for the construction and maintenance of healthy and energy-efficient buildings. ECA-IAQ prepares status reports and guidelines on: indoor pollutants that contribute predominantly to total human exposure; criteria and methods for source evaluation and control; ways to achieve healthy indoor environments; interaction between indoor-air quality and energy use in buildings; and risk assessment in buildings. ECA-IAQ is the European focal point for indoor-air-quality research and evaluation. Organizations such as WHO (World Health Organization) and US EPA (Environmental Protection Agency) collaborate with ECA-IAQ.
www.ei.jrc.it/ethh/projects/ECA-IAQ

Three SCA projects within the Environment programme (4th FWP) of the EC (DG XII) are in progress:

Biomarkers for Risk Assessment in Human Metal Sensitivity (BRAHMS)

This project is a multidisciplinary collaboration (there are 6 partners from different European countries) aiming at elucidating molecular and cellular responses of human skin exposed to immunotoxic metals such as nickel, cobalt and chromium. The project will end in February 1999.

The role of the JRC is to carry out cellular toxicological studies to ascertain the effect of immunotoxic metals (nickel, cobalt and chromium) on a human keratinocyte cell line (HaCaT). These studies include their cytotoxicity, uptake and intracellular distribution and the detection of molecular endpoints (expression of selected cytokines, induction of specific proteins and/or of metal-protein complexes) by molecular biology and protein chemistry-based techniques. www.ei.jrc.it/ethh/projects/BRAHMS



Isoelectrofocusing (IEF) on cellular extracts used for the identification of a specific band, which appears only after cell exposure to increasing concentrations of a xenobiotic (1, 1 mM $NiCl_2$; 2, 0.01 mM $NiCl_2$; 3 control without $NiCl_2$)

Neurotoxicity of metals

This project is an *in vitro* mechanistic approach to risk assessment and biomonitoring of neurotoxic metals. The general aim is to characterize, by using *in vitro* models and methods, the neurotoxic effects of manganese, aluminium and mercury. The main goal of the project is to improve risk assessment for neurotoxicity, by providing mechanistic information on the action of toxicants at cellular and molecular levels. The development of peripheral markers as surrogate indicators of neurotoxicity, to be used in epidemiological studies on populations at risk, is a complementary objective. The project, which includes 5 partners from different European countries, will end in March 1999.

The role of the JRC is to carry out cellular toxicology and analytical validation studies to ascertain the effective dose of neurotoxic metals (mainly manganese and mercury). Different cell models, namely, established cell lines (PC12), differentiated and not differentiated, as well as primary cultures (cerebellar granule cells), are used to study cellular and molecular targets of neurotoxic effects.
www.ei.jrc.it/ethh/projects/Neurotoxicity

Endocrine-Disrupting Ability of Environmental Pollutants (EDAEP)

The main objectives of this project are: to develop and apply QSAR techniques and models to the screening of high-production-volume chemicals according to their binding to estrogen, androgen and thyroid hormone receptors, based on the existing experimental data; to develop and implement an *in vitro* and *in vivo* testing strategy for endocrine-disrupting chemicals; and to establish a list of potentially endocrine-disrupting chemicals to be considered in validated testing systems. The project will end in February 2000.

The project is co-ordinated by the JRC (Environment Institute) and involves the participation of 7 partners from different European countries.
www.ei.jrc.it/ethh/projects/EDAEP

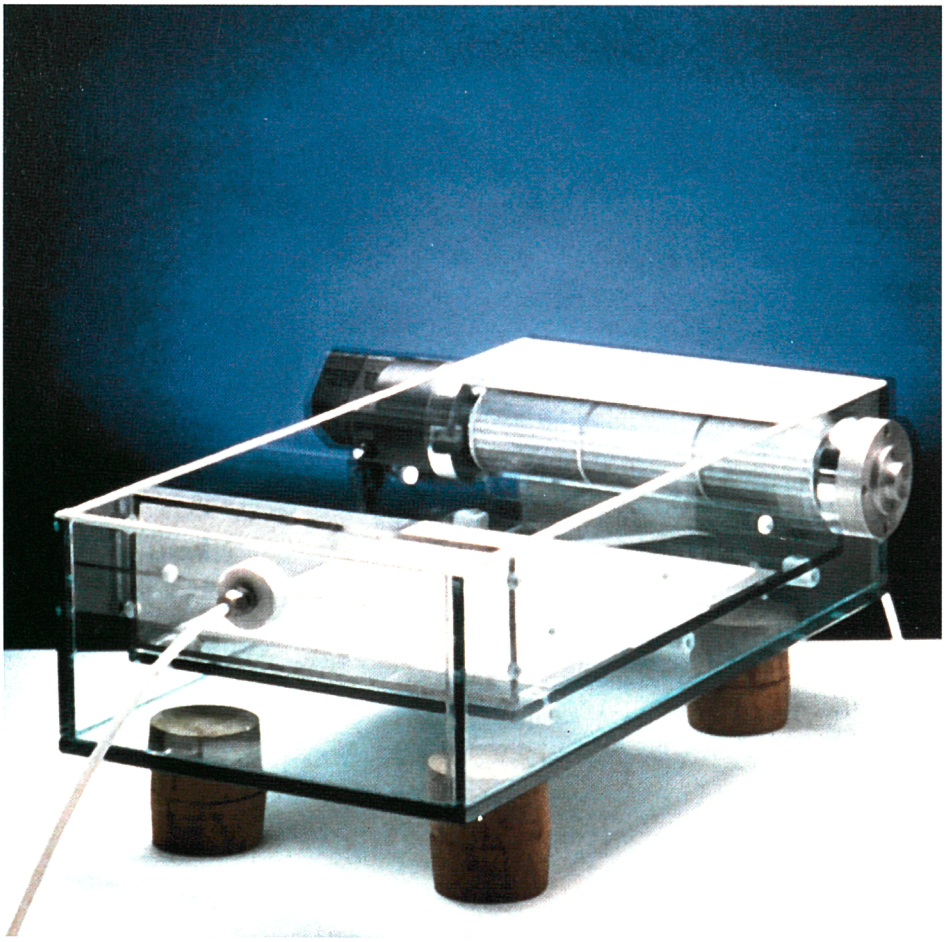
Another SCA, within the Standards, Measurements & Testing programme (4th FWP) of the EC (DG XII), is in progress:

Volatile Organic Compounds Emissions (VOCEM)

Small environmental test chambers are used to measure VOC emissions from indoor materials and products. Comparison exercises carried out among European and US laboratories, following existing guidelines for these measurements, showed discrepancies/uncertainties of a size incompatible with material certification/labelling needs. The VOCEM project, through the co-operation of four research institutes and four industrial companies, aims at reducing errors to within an acceptable range.

Selected Publications

De Bortoli, M., Ghezzi, E., Knöppel, H., Vissers H. (1997). A new test chamber to measure VOC emissions under controlled air velocity and turbulence. Submitted to *Indoor Air*.



A new small test chamber for the measurement of VOC emissions from indoor materials and products was completed

This requires research on the following topics: preparation of particularly homogeneous test materials (carpet, PVC, paint); control of packaging and transport to the test laboratory; effect of chamber air velocity on emission rate; losses (sinks) of the emitted VOCs within the chamber; and improvement of chemical analysis. Inter-laboratory comparisons will be carried out to validate the method resulting from such research efforts.

The project is aimed at improving small-chamber measurements of VOC emissions from indoor materials and products. It will be completed by the end of 1998.
www.ei.jrc.it/ethh/projects/VOCEM

KNOW-HOW, INSTRUMENTS & LABORATORIES

Animal house

Allows small animals (mice, rats, rabbits, etc.) to be kept and *in vivo* short-term toxicological experiments to be carried out in full respect of EC Directives (in particular, EC 86/609). Furthermore, this facility is equipped for:

- cell isolation and primary cell culture
- cell toxicology studies, either *in vitro* or *ex-vivo/in vitro*.

Cell culture laboratory

Allows the culture of primary cells and established cell lines and is equipped with suitable apparatus (microplates technology, chemiluminiscence, fluorescence, etc.) for the study of relevant endpoints (e.g. apoptosis, intracellular signalling) using molecular toxicology and cytotoxicity methods.

Molecular biology and biochemical laboratory

This facility is designed to set up and hold standard and refined methods for the study of relevant molecular end-points of interest in environmental toxicology studies. In particular:

- the study of nucleic acids (DNA, RNA) and selected gene activities has been set as a first priority, including DNA and RNA extraction and characterization, polynucleotide chain reaction (PCR) analysis followed by electrophoretic detection of amplified sequences (such as randomly-amplified polymorphic DNA, RAPD, and arbitrary fragment length polymorphism, AFLP)
- equipment for protein chemistry and enzymological studies is available, such as chromatography (including a versatile fast performance liquid chromatography, FPLC, system), spectrophotometry and 1D as well as 2D electrophoresis
- post-electrophoretic analysis is run by a computerized video-documentation system.

Walk-in test chamber for indoor air quality research (INDOORTRON)

Consists of a 30 cubic metre facility featuring controllable temperature (15-40 °C), relative humidity (20-90%), air quality and air exchange rate (0.1-2 ach:air exchange per hour). Using this emission chamber, one can:

- perform emission and adsorption testing of equipment or large pieces of material
- up-scale the small-chamber measurements to real-life situations
- test the efficiency of air-cleaning devices
- study human reactions (e.g irritation, annoying odours) under controlled conditions.

www.ei.jrc.it/ethh/facilities

Selected Publications

■ Sacco, M.G., Zecca, L., Bagnasco, L., Chiesa, G., Parolini, C., Bromley, P., Mira Catò, E., Roncucci, R., Clerici, L.A., Vezzoni, P. (1997). A Transgenic Mouse Model for the Detection of Cellular Stress Induced by Toxic Inorganic Compounds. *Nature Biotechnology*, **15**:1392-1397.

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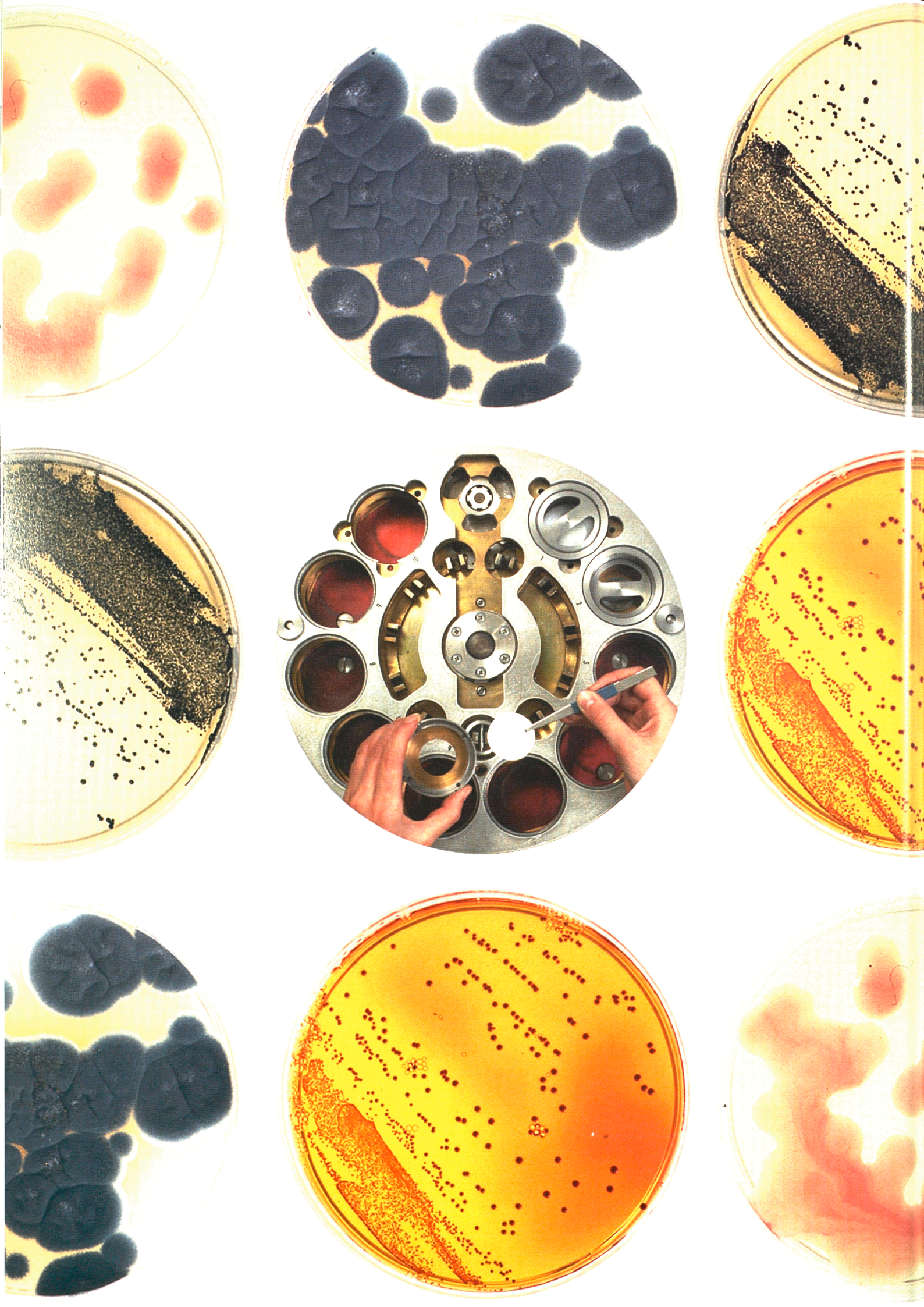


CONSUMER PROTECTION & FOOD

Food & Drug Analysis

Unit Head: **Jean-Marie Martin (*f.f.*)** • **Elke Anklam (*from February 1998*)**

FOOD & DRUG ANALYSIS

CONSUMER PROTECTION & FOOD

THE UNIT'S MISSION

The central mission of the Food & Drug Analysis Unit is to support the protection of the European consumer in the field of safety and quality of food. The Unit validates and harmonizes analytical methods for the detection of substances causing unwanted effects in the consumer, and monitors their occurrence in food and feedstuffs.

FIELDS OF ACTIVITY

The main activities of the Food & Drug Analysis Unit are focused on peri-normative research with an emphasis on harmonization and validation of analytical methods and the monitoring of specific compounds.

The Unit provides scientific and technical support to the Directorates

- DG III (Industry)
- DG VI (Agriculture)
- DG XXI (Customs and Indirect Taxation)
- DG XXIV (Consumer Policy and Consumer Health Protection)

in the analysis of ingredients, additives and residues and contaminants in food, feedstuffs and other consumer goods, as well as food-packaging materials, with a view to ensuring food safety, food quality and the effective development and implementation of food legislation.

Homepage: www.ei.jrc.it/fda/intro

Selected Publications

- Lipp, M., Anklam, M., (1997). Application of the evaporative light scattering detector in food analysis. *Seminars in Food analysis*, **2**:1-10.
- Anklam, E., Gaglione, S., Müller, A. (1997). Oxidation behaviour of vanillin in dairy products. *Food Chemistry*, **60**(1):43-52.

MAJOR ACHIEVEMENTS IN 1997

The Unit has initiated validation studies on:

- GMO (genetically modified organisms)
- BSE (bovine spongiform encephalopathy).

To support the corresponding Directorates, the following projects have been awarded:

- DG III: development of suitable analytical techniques for the determination of vegetable fats other than cocoa butter in chocolate
- DG III: development of suitable analytical techniques for the determination of the geographical and botanical origin of honeys
- DG XII-SMT: support for food control – Internet compendium of analytical methods for food packaging material
- DG XXI: development of isotopic method for detection of adulteration of olive oil.

- A Workshop on Paper and Board in Food-Contact Applications was organized and held in Ispra (I), 28-29 October 1997.
- A Symposium on Microbiology of Food and Cosmetics in Europe was organized and held in Ispra (I), 15 April 1997.
- A meeting of EU experts on the wine and isotopic data bank was organized and held in Ispra (I), 24 September 1997.

Selected Publications

- Simoneau, C., Castle, L., Gilbert J., eds. (1998). *Proceedings from the 1st Workshop on Paper and Board for Food Contact Applications*. Ispra, Italy, 28-29 October 1997. EUR Report, *in press*.
- Marengo, G., Pastoni, F., Zampollo, F., Kelly, P. (1998). Microbial cells damage induced by preservatives and other toxic substances. *Kinetic studies. Sixth International Symposium on Microbiology of Food and Cosmetics in Europe: Containment of food-transmitted risks presented by emerging pathogens*. Ispra, Italy, 15 April 1997. EUR Report, *in press*.

FUTURE ACTIVITIES

The creation of a European Consumer Protection Laboratory (ECPL) is foreseen in 1998. This laboratory without walls will combine the relevant activities of JRC-Ispra and JRC-Geel in the field of consumer protection and will be co-ordinated by the Food & Drug Analysis Unit. The activities of the future ECPL will be devoted to problems of food quality, safety and legislation.

ACTIVITIES & PROJECTS

Food safety

Natural toxicants: mycotoxins and alkaloids

Mycotoxins are toxic compounds produced by moulds in food and/or feedstuffs. Some of them present a high carcinogenic potential for humans. Suitable analytical methods for the determination of such toxins in various food matrices (e.g., pistachios, peanuts, figs, paprika, baby food) were developed.

The thornapple (*Datura stramontium)* produces alkaloids which can cause severe health problems for livestock if present in feedstuffs. The official method to-date consists of counting the seeds of *Datura* species in feedstuff. However, to protect consumers better, the direct determination of the major toxic alkaloids is required. A rapid screening method for the determination of such alkaloids was developed.
www.ei.jrc.it/fda/projects/Mycotoxins

Fruit of the thornapple (Datura stramontium)

Microbiology

Injured cells were monitored in various food matrices and cosmetics. Such cells were found during a large study on water for human consumption. This was especially the case where water had been treated with chlorine.

An immuno-enzymatic method was improved in which enterotoxic strains of *Escherichia coli* O157:H7 could be identified in less than 8 hours after the initial inoculation of the sample.

Rapid microbiological methods were developed and improved for the monitoring of *Salmonella* in farm animals.

A Symposium on Microbiology of Food and Cosmetics in Europe was organized by the Unit, at Ispra.
www.ei.jrc.it/fda/projects/MicrobiolInvestigat

Food packaging

Most food products are generally packaged to protect them from contamination and to extend shelf life. Packaging materials include plastics, paper/board, metallic cans, glass etc. The ingredients of packaging must not, however, be allowed to migrate into the food and become a source of contamination. Ongoing activities include:

- *Dissemination of information*

  The creation of a European database of reference substances and other pertinent information, characteristic spectra and other physical-chemical data was initiated. The substances will be made available on request.

  A Workshop on Paper and Board in Food-Contact Applications was organized at Ispra (28-29 October 1997).

  The development of a World Wide Web site dedicated to the dissemination of information on methods of analysis and legislative documents was initiated.

Selected Publications

■ Simoneau, C., Hannaert, P. (1998). Stability testing of selected plastic additives for food contact in EU aqueous, fatty and alternative simulants. *Food Additive and Contaminants, in press.*

- *Comparison of migration methods*

  Methods for testing the migration of substances from food packaging into simulated liquid food were investigated in collaborative studies. The most recent projects have focused on the time-temperature relationship in the various fatty-food simulants, comparison of time-temperature exposures for multilayer materials, and stability testing of packaging additives.

- *European monitoring*

  Surveys were completed on the detection and quantification of toxicants and contaminants in packaging materials in contact with foods.

  In paper and board, benzophenones and particularly Michler's ketone (MK) were monitored. MK is used in UV-cured printing inks as a hardener and is a suspected carcinogen. A survey based on 150 samples was completed.

  In metallic packaging, BADGE (bisphenol-A-diglycidyl-ether) is a constitutent of the lacquer used in can coatings and can contaminate foods such as canned fish in oil. A European survey was completed on the contamination of canned fish in oil in about 400 samples from all Member States.

www.ei.jrc.it/fda/projects/FoodPackaging

Pesticides

The Unit is contributing to the monitoring programme of the European Commission. This includes statistical data evaluation of proficiency tests and of the results of European and national monitoring programmes.

Food processing and unwanted effects

HMF (5-hydroxymethyl furfural) is suspected of being carcinogenic for humans; it can be formed during heat treatment of food that is rich in sugars. A large number of vinegar samples from various sources were analysed to obtain an overview of the concentration of HMF. Relatively high amounts could be found in balsamic vinegar samples where a clear dependence on the age of the vinegar could be affirmed.

Biogenic amines occur in fermented food and are products of metabolism or microbiological degradation. Most of them are considered to be toxic and, in humans, can cause symptoms similar to those of an acute allergic reaction. Thirteen metabolic amines were monitored in various balsamic- and sherry-vinegar samples, and nine of the thirteen were found to be present. It was observed that the content of longer-chain amines in the balsamic-vinegar samples decreased with increasing age of the vinegar.

3-MCPD (3-monochloropropandiol) can be produced during the processing of food, especially by hydrochloric acid hydrolysis of proteins and can therefore be found in sea-sonings, for example. The substance seems to be carcinogenic to humans. The Unit worked on the optimization of analytical methods for the determination of 3-MCPD in various food matrices and participated successfully in several collaborative trial studies.

Food quality

BEVABS (Bureau Européen des Vins, Alcools et Boissons Spiriteuses)

Adulteration of wine by the addition of sugars of a different botanical origin and the watering of wine are major problems in the wine-producing countries. The main purpose of BEVABS is to maintain an isotopic data bank for a collection of authentic wines from European Member States. Results of the 1996 vintage were presented and approved during the meeting of the EU experts on the wine and isotopic data bank. Thus, results of vintages 1991 to 1996 have been validated and stored in the wine data bank. The Unit contributed to the recent adoption of a new isotopic method (oxygen-18/oxygen-16 isotope ratio) for the control of wine (EEC Regulation N. 822/97).

Validation of analytical methods for the analysis of spirits

Eleven analytical methods for spirits are expected to be adopted as official EU methods to support the monitoring of compliance of spirits with EEC 1576/89. The Unit, together with three other partners, is organizing the validation studies of these methods.

Fruit juices

Fruit juices can be adulterated by the addition of water and/or sugar. To develop suitable analytical tools for the detection of such fraud, various fractions of citrus fruit juices (i.e. water, sugar, pulp, organic acids) were characterized for their isotopic composition. Furthermore, in the frame of the FIT (food analysis using isotopic techniques) network, a collaborative study was organized to determine the carbon-13 content of organic acids.

Olive oil

The adulteration of olive oil with exogenous oils, particularly hazelnut oil, is very difficult to identify by conventional chromatographic methods. A study using advanced techniques (isotope ratio mass spectrometry and nuclear magnetic resonance) for the detection of this fraud was initiated. An appropriate technique for the determination of the oxygen-18 content in oils has already been developed.

Selected Publications

■ Angerosa, F., Camera, L., Cumutini, S., Gleixner, G., Reniero, F. (1997). Carbon stable isotopes and olive oil adulteration with pomace oil. *Journal of Agriculture and Food Chemistry*, **45**:3044-3048.

Food analysis using isotopic techniques (FIT)

As leader of the "State of the Art" Working Group, BEVABS presented, in 1997, a bibliographical review of isotopic methods used in food analysis. An exchange of scientists between JRC and other institutions was organized to share experience and know-how in isotopic analysis. www.ei.jrc.it/fda/projects/IsotopicTechniques

Vitamins

Current methods for the determination of the vitamin content of baby food use organic solvents for extraction. New extraction methods for the determination of fat-soluble vitamins in food (infant formulae and canned baby food) were developed using supercritical fluids instead of hazardous organic solvents. This work is performed in collaboration with other laboratories in the frame of a shared-cost action project.

Food Legislation

Milk-fat content

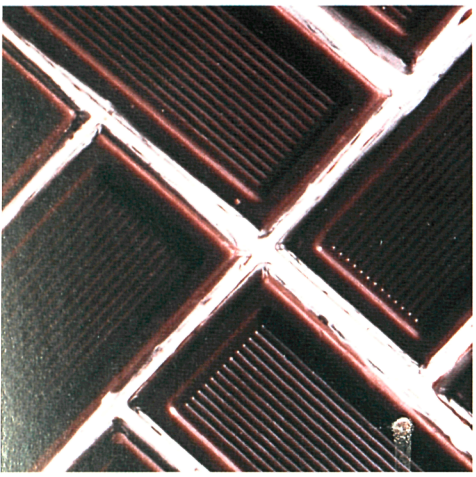
The presence of butyric acid can be taken as an unequivocal indicator of the presence of milk fat. The former official method to determine the milk-fat content in imported or exported products was based on the assumption that milk fat contains 3.7% butyric acid. However, today's milk fat contains only about 3.4% butyric acid. Therefore, the former official method always resulted in a milk-fat content that was too low. The method was revised by DG XXI and now reflects the actual composition of milk fat (COM 203/98, OJ L21, 28.1.1998, p. 6).

Selected Publications

■ Lipp, M., Anklam, E. (1997). Problems related to the conversion factor for the calculation of the milk fat content by using the official European method based on butyric acid. *Milchwissenschaften*, **52**(11):611-614.

Selected Publications

■ Anklam, E., Bassani, M.R., Eiberger, T., Kriebel, S., Lipp, M., Matissek, R. (1997). Characterization of cocoa butter and other vegetable fats by pyrolysis mass-spectrometry. *Fresenius' Journal of Analytical Chemistry*, **357**:981-984.



Chocolate

Due to the harmonization of the Directive on chocolates, suitable methods for the determination of other vegetable fats than cocoa butter in chocolate are needed. The Unit is co-ordinating a project involving several laboratories from the Member States to meet these needs. Several analytical methods were applied to evaluate their potential for the detection of mixtures of cocoa butter and other vegetable fats. Methods under investigation include the determination of triglycerides, fatty acids, trans-fatty acids, sterols and sterol esters, as well as the application of fat-screening methods such as pyrolysis mass spectrometry.

Honey

An evaluation study of methods for the determination of the geographical and botanical origin of honey was carried out. The Unit is co-ordinating a project to develop and validate methods for this purpose. Methods under investigation consider several constituents of honey, such as pollen, sugars, carbohydrates, flavonoids and trace elements, as well as physical parameters such as crystallization and melting behaviour.

Genetically modified organisms (GMO)

According to the EC Novel Food Regulation (258/97), a novel food or food ingredient shall be deemed to be no longer equivalent if scientific assessment can demonstrate that the characteristics are different from those of a conventional food. The Unit co-ordinates a joint project with the Institute for Reference Materials and Measurements (IRMM) of the JRC Geel to carry out validation of a screening method capable of detecting 26 of the 28 GMOs currently approved or awaiting approval. The validation study comprises the production of certified materials and the participation of about 40 laboratories from 13 Member States. A video was produced to facilitate the introduction of the method into inexperienced laboratories.

Cosmetics

Entries in the official Cosmetics Ingredients Inventory were checked for chemical consistency between the INCI (International Nomenclature Cosmetic Ingredient) names, the chemical names and the CAS (Chemical Abstract Service) registry numbers. Missing data, chemical names and CAS registry numbers were identified. Besides these projects, the Unit has provided scientific and technical support to various Units of the Environment Institute and other institutes in the field of inorganic analysis.

KNOW-HOW, INSTRUMENTS & LABORATORIES

The Unit is experienced in dealing with such questions as:

- what is the origin and composition of food?
- is food authentic?
- is there an impact of food packaging materials on human and animal health?
- what is the risk to human beings and animals from contaminated food or feedstuffs?

The Unit's know-how includes the application and development of chemical, physical and microbiological methods to ensure sufficient consumer protection, food quality and food safety, and to support the development and implementation of food legislation.

Structural and chemical properties of samples can be analysed by classical analytical methods, X-ray diffraction, mass spectrometry and nuclear magnetic resonance [NMR] spectroscopy. Major and minor inorganic compounds are analysed by atomic absorption spectroscopy, using inductively-coupled plasma in a graphite furnace, X-ray fluorescence, ion chromatography, electroanalytical facilities and other methods.

Food, feedstuffs and other consumer goods are analysed for their ingredients, additives and contaminants, using modern chromatographic equipment. The methods available are gas chromatography (GC), high-performance liquid chromatography (HPLC) coupled to various detectors (mass spectrometric detector, evaporative light scatter detector, nuclear magnetic resonance spectroscopic detector, electrochemical and several other kinds of detectors) and capillary electrophoresis.

For sample preparation, modern extraction methods are used. The Unit is also specialized in the application of supercritical fluid extraction for food analysis.

The Unit has long-standing experience in the determination of natural isotopes such as hydrogen-2 (deuterium), carbon-13, nitrogen-15 and oxygen-18 in food by NMR, isotope ratio mass spectrometry (IRMS) and IRMS coupled to GC and HPLC.

Statistical data evaluation, using multivariate data analysis and other techniques, is applied in support of the instrumental analytical techniques and for the data evaluation in collaborative or interlaboratory trials.

www.ei.jrc.it/fda/facilities

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Detection of genetically modified organisms

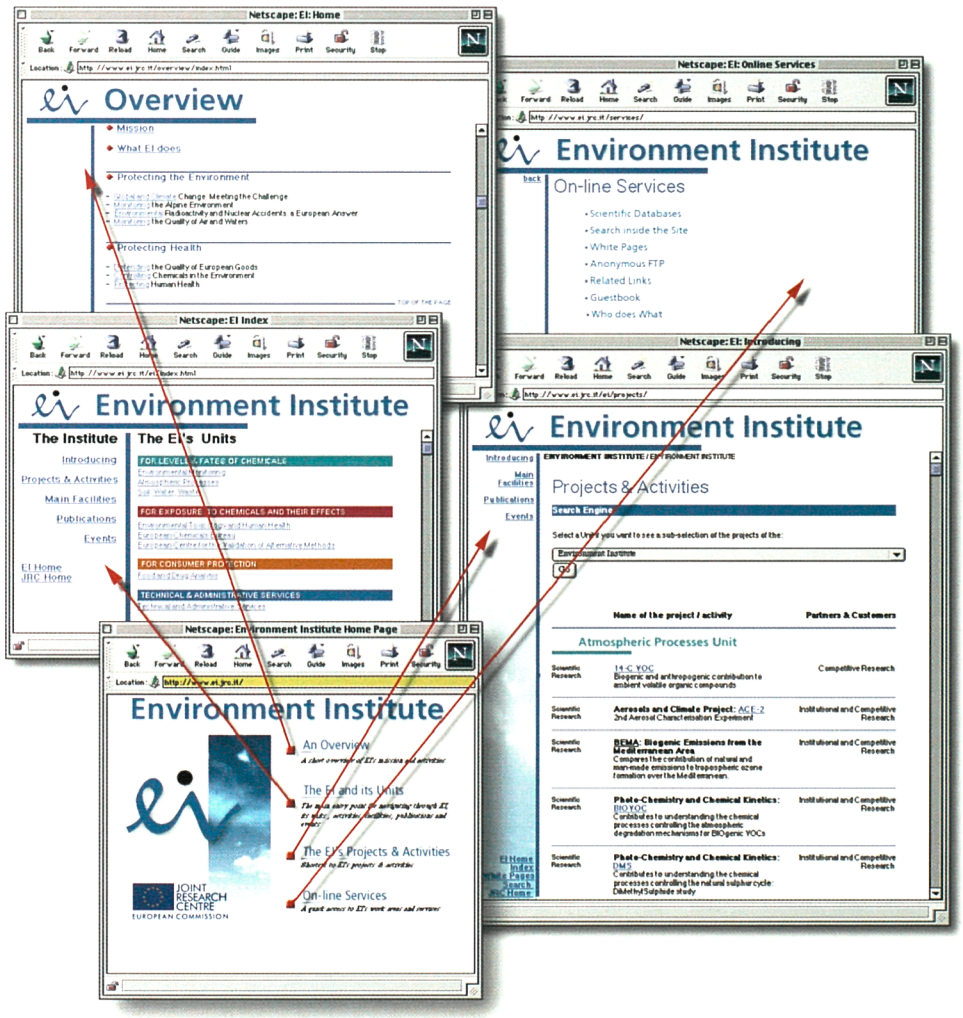
THE EI WEB HOME PAGE

Projects, activities and publications of the Institute with an improved navigation software for technical and non-technical browsers.

The Environment Institute's (EI) web site (http://www.ei.jrc.it) is based on a communication architecture that combines static and dynamic information at different hierarchical levels. The information ranges from the very general, for example the Institute's mission, its staff and organization, its partners and customers, to the more specific and technical when related to the EI Units, their facilities, their projects and activities, the publications, the events and on-line services. All this information can be easily obtained by horizontal and vertical navigation through a hypertext structure. The information becomes more technical the further one navigates vertically. The final level of this vertical navigation is represented by a "Projects and Activities" home page for each Unit. Its contents are directly managed by the project leaders at the Institute. These pages are the most dynamic part of the EI web site and may be distributed over different servers.

A detailed description of the EI's web site communication architecture, as well as examples of its dynamic part, can be found in the publication quoted on the margin.

The present annual report can be found at: http://www.ei.jrc.it/ report/rep97pdf.html



Selected Publications

Kephalopoulos, S., Petit, P., Saltelli, A., Breitenbach, L. (1997). The application of the Web Technology as a Power and Interactive Information Service in the field of Environmental Sciences: the example of the JRC Environment Institute's Web Site. *Proceedings of the ECO-INFORMA '97 Conference*, 6-9 October 1997, Munich (D), 41-46.

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